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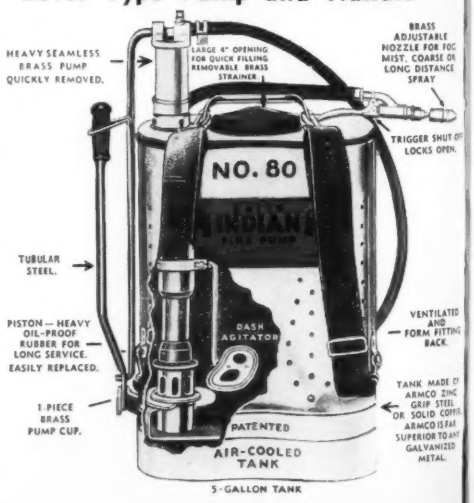
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VOLUME 56 • NUMBER 10 · OCTOBER 1958

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Publication office, 425 Mills Building, 17th Street at Pennsylvania Avenue N. W., Washington 6, D. C. Address all correspondence concerning editorial or business matters to JOURNAL OF FORESTRY, 425 Mills Building, 17th Street at Pennsylvania Avenue N. W., Washington 6, D. C. Published monthly. Subscription $7.50 per year; single copies 75 cents. Missing numbers will be replaced without charge provided claim is made within thirty days after date of the following issue.

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CONTENTS

COVER: A stand of mature Wisconsin quaking aspen. Average 18 to 20 cords per acre. *(Photo courtesy Wisconsin Conservation Department)*

Pales Weevil Rapidly Becoming Serious Pest of Pine Reproduction in the South — *C. F. Speers* 723

Allowable Cut as a New Function of Growth and Diagnostic Tallies — *L. R. Grosenbaugh* 727

A Study of Aspen-Balsam Fir Cutting Methods in Northern Wisconsin—Five-Year Results — *John H. Cooley* and *W. B. Lord* 731

Soil Temperatures During Burning Related to Postfire Seedbeds on Woodland Range — *J. R. Bentley* and *R. L. Fenner* 737

Composite Aerial Volume Table for Southern Pines and Hardwoods — *Gene Avery* 741

Pole Blight—How It May Influence Western White Pine Management in Light of Current Knowledge — *Charles D. Leaphart* 746

Effects of Seedbed Conditions on Yellow-Poplar Regeneration — *Stephen G. Boyce* and *Robert E. Parry* 751

Economics of Site Preparation and Land Regeneration in the South: Example of an Industry Concept — *George Anderson* 754

Growth of Thinned Ponderosa Pine in Western Montana — *A. R. Stage* 757

Notes 761

Shortleaf Versus Loblolly Pine in North Mississippi; The Use of Tetrazolium for Quick Germination Tests; How Much Douglas-Fir Will Grow on an Acre?; The Extraction of Large Wood Samples from Living Trees; Forestry Education in Spain; Aids for Using Wedge Prisms; Aerial Application of Benzene Hexachloride for the Control of Cone Insects on a Slash Pine Seed Production Area.

Points of View 769

Some Comments Regarding the JOURNAL; Comments on "Effect of Soil Amendments on Growth of Shortleaf Pine"; Germination Conditions for Western Hemlock.

Reviews 776

The Tree Identification Book; A New Method for the Practical Identification and Recognition of Trees; Nature is Your Guide; Experiences with the Weather; Forest Fertilization; Publications of Interest.

Current Literature 783

Society Affairs 785

Forestry News 792

Index to Advertisers 800

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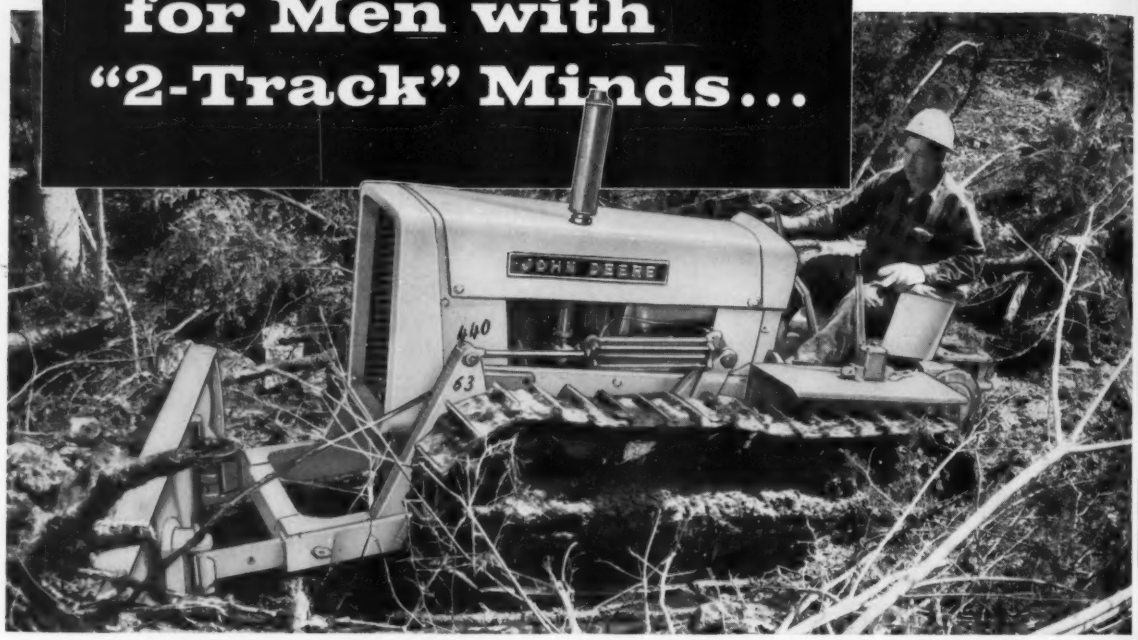

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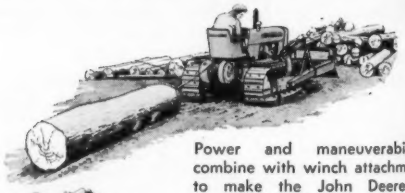

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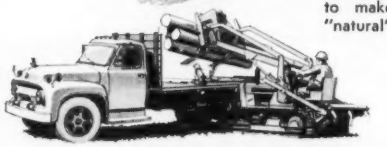

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Pales Weevil Rapidly Becoming Serious Pest of Pine Reproduction in the South

C. F. Speers

Forest entomologist,
Southeastern Forest Experiment Station,
Forest Service,
U. S. Department of Agriculture

THE PALES (*Hylobius pales*) and pitch-eating weevils (*Pachylobius picivorus*) are rapidly becoming serious pests in the South. This is especially true in plantations established on cutover or damaged lands. Weevils are attracted to areas where recent cutting or weakening of pines has occurred, and in these areas they feed on the bark of young pine seedlings, causing injury or death. Serious seedling mortality throughout the South has become common during the last 9 years, with losses due to weevil attack running as high as 90 percent. With the use of planting to re-establish pine stands increasing rapidly, these weevils will become even more important in the future. Because the habits of the pales and the pitch-eating weevils are believed to be similar, only the pales will be discussed.

The species is native to North America and was described in 1797. Except for several scattered general references on the abundance of the weevil around pine trees or pine products, no mention was made of the feeding activity of the adults on the bark of young pine seedlings until 119 years later when Carter (*2*) reported that this weevil was the cause of the failure of pine reproduction on cutover areas in New England. Prior to this it was commonly thought that released hardwoods crowded out the pines. Beal and McClintick (*1*) were the first to report serious damage by the pales weevil in the South. A few years later, Sentell reported serious weevil damage to pine plantations established on burned areas in Louisiana (*6*). Since 1949 reports of pales damage throughout the South have been common.

Range and Hosts

The insect is found throughout the eastern range of pine from Texas to Canada. Carter (*2*) determined that 14 hosts were fed upon, including species in the following genera: Pinus, Picea, Pseudotsuga, Tsuga, Abies, and Juniperus. Peirson (*4*) added the genera Larix, Thuja, Betula, and Fraxinus, while Beal and McClintick (*1*) added Cupressus. It is doubtful if any conifers which occur in our southern forests are completely immune to attack.

Damage

The adult weevils are attracted from long distances to stored logs, pulpwood, and lumber; to cutover areas and to burned, blow-down, beetle-killed, or disturbed areas where recent weakening of the the trees has occurred. Prior to laying eggs in stumps, slash, roots, and weakened trees, the weevils feed on the bark of young pine. Feeding preference is generally for the bark of 1- or 2-year-old seedlings, but where these are absent the weevils feed on the bark of older trees. Damage is generally not serious on older trees since only twigs or limbs are killed rather than entire trees.

Adult feeding occurs principally at night or on cloudy days. During the day the weevils generally hide in the soil near the base of seedlings. The injury has the appearance of a series of small holes, pits, or gouges which are chewed in the bark. When these pits are numerous, they girdle the seedling (Fig. 1) or branch and cause its death.

In 1956 considerable weevil feeding took place on the current season's growth of loblolly pine in the Duke Forest, North Carolina. Weevils also damaged slash pine in South Georgia that fall, after shoot

FIG. 1.—Seedling girdled and killed by the pales weevil.

elongation and the formation of new buds. In both cases the weevils fed on the newly formed soft bud tissue, along the twigs, and on the bases of the needles. Many times, when feeding was heavy, the "leader" was killed back to the top whorl. This damage did not kill the entire seedling, but did result in bushiness (Fig. 2), because all of the remaining branches competed for height dominance. The injury could easily have been mistaken for that caused by the Nantucket pine moth.

Various studies and observations show that the most severe injury to seedlings is found in the vicinity of fresh stumps or weakened trees. Carter (*2*) observed that most severe damage occurred when pines were planted 10 to 15 feet on the leeward side of stumps and that it sometimes extended as far as 300 feet from the edge of the old stand if cutting proceeded in strips. Friend and Chamberlin showed that the difference in distance from the stump was significant between uninjured and killed trees (*3*). Beal and McClintick determined that the average number of killed pine seedlings varied directly with the number of available seedlings and inversely with the distance from the edge of a clearing (*1*).

Damage to reproduction depends considerably on the type of area planted. Pine planted on old fields, cutover hardwood areas, and in regions where no cutting of pine has occurred for several years, are not likely to be noticeably affected because few weevils exist in such areas. However, in localities where continuous pine logging occurs, large weevil populations build up and move from one breeding area to another. Where deterioration occurs at a slow rate, most stumps remain suitable for breeding for two or possibly three seasons (*2*).

Thatcher determined that only minor losses may be expected in the South when at least 9 months are allowed to elapse between cutting and planting (*9*). Termites, wood borers, other insects, and fungi cause a more rapid breakdown of pine bark tissues and roots in the South than in the North. Higher temperatures in the South dry out the cambial layer more rapidly and it becomes unsuitable for weevil breeding in a shorter period of time.

FIG. 2.—New growth intensively fed upon and killed by the pales weevil. This type of feeding results in a bushy seedling.

Life History

The life history of the pales weevil in central Massachusetts was determined by Peirson on the Harvard Forest (*4*). Most weevils come out of hibernation from late April to the latter part of May and begin feeding near the place of emergence before migrating in mid-June to more recent logging operations. Upon reaching the new breeding areas, the beetles feed on slash or bark if suitable seedlings are not present. During flight from one breeding area to another, the weevils may stop enroute to feed for a short time. The adults (Fig. 3) begin laying eggs soon after arrival at new breeding areas. The white eggs are laid singly in the roots of recently cut pine stumps or weakened trees, and the weevils may burrow from a few inches to more than a foot into the soil for this purpose. The eggs hatch in 10-14 days and the grubs begin tunneling under the bark. In small roots, the sapwood is deeply grooved by grub tunnels. The larvae reach full size by September and pupate in the sapwood in individual cells covered covered over with shreds of excelsior-like wood. The new adults emerge in late September or October and feed on

young pine seedlings prior to entering the soil for winter hibernation.

While the habits of the beetle in the South are believed to be much the same, detailed studies will be required to determine the similarities and differences. Heavy feeding periods by adults have been observed in both spring and fall in the Northeast, with most severe injury occurring in the fall. Observations in the South indicate that most of the severe weevil injury occurs in the spring of the year, from March to June. Trap collections in Asheville, North Carolina, in 1956 and 1957, showed that about 80 percent of the weevils are in flight in the spring. Current life history studies in the South should ascertain the period of development, number of generations, and longevity of the adults.

Control in Natural Reproduction on Cutover Pine Land

On cutover pine lands an adequate number of natural seedlings can be maintained through management, application of insecticidal sprays, or trapping.

When several thousand seedlings per acre are present at the time of cutting, such as might occur when the shelterwood method of management is used, the weevils may kill many of the seedlings but still leave enough young trees unharmed to adequately restock an area. The Harvard Forest recommends cutting in a seed year or thinning before cutting to stimulate seed production (*4*).

When only limited numbers of seedlings occur, beetle activity may prevent regeneration. In such a situation, protection of 600 to 700 seedlings per acre may be desirable or as many as are required for proper stocking. Two to three ounces of a 2-percent water emulsion of aldrin or heptachlor applied to seedlings and the soil surface surrounding them provide excellent protection.

It was suggested by Peirson (*4*) that the elimination of slash and logging debris from cutover land and the burning of logging slash over stumps might lower the attraction of these areas to the beetles, thus decreasing the breeding area in the stumps; however, studies made later in large, severely burned areas disproved this idea (*5*). Likewise, according to observations in the South, burning of cutover areas does not lower their attractiveness to weevil attack.

FIG. 3.—A lateral view of the pales weevil, enlarged.

Care should also be exercised that pine logs and lumber are not concentrated close to young pine stands, because the beetles will be attracted to these products and will feed on young pine in the surrounding area.

Control on Cutover Pine Land to be Planted to Pine

Planting of untreated stock should be avoided or considered with caution in areas adjacent to recent cuts, where stumps and slash are attractive and roots are suitable for breeding. Caution must also be exercised in planting areas where trees are continuing to die as a result of wildfires or other causes, since the date of the last dying trees will determine whether protective measures need to be taken.

Weevil damage in the South can be reduced by waiting until at least 9 months have passed between cutting and planting (*9*). This waiting period allows the area to lose its attractiveness to weevils and also allows deterioration of stumps, slash, and roots.

On small areas up to an acre in size, trapping the beetle offers some control possibilities. Near Asheville, North Carolina, 25 treated seedlings were planted in the spring of 1956 on a small area that had been clearcut the previous fall. Although over 3,500 weevils were collected in traps made of pine bolts and branches during the spring-fall period on this area, none of the seedlings were seriously injured.

In many instances it may not be desirable to wait for a growing season or more to pass before establishing seedlings because of the danger of hardwoods occupying the area, higher planting costs, loss of a year's growth, and other factors. To avoid a waiting period, it may be desirable to either plant the area as soon as possible or cut in a good seed year.

In the South, if a stand is established by direct seeding, it should not be necessary to wait for a growing season to pass after cutting before establishing reproduction. Seedlings are rarely attacked before the end of the first growing season, and by this time the weevils are no longer in the area.

If the seedlings are planted before one growing season has elapsed, they may be protected from weevil attack by one of the following methods: (1) dipping the tops in an insecticide prior to planting, (2) application of ⅛ cup of granular insecticide to the soil around each dipped seedling, and (3) spraying the seedlings and soil surface immediately surrounding them.

Dipping in 2-percent water emulsions of aldrin or heptachlor offers good protection for an expenditure of about 20 cents per acre for insecticide and can be applied as a form of insurance where weevil damage may be expected to occur. Dipping plus 2-percent granular aldrin or heptachlor provides very good protection for an expenditure of about one dollar per acre and might be used for protecting plantings of intermediate value. Spraying with 2-percent emulsions of aldrin or heptachlor offers excellent protection and would generally be employed to protect high-value seedlings or where seedlings are not dipped and where injury is found in progress (*8*). Spraying, at a cost of about five dollars per acre, is

the most expensive of the three treatments, since more insecticide is used and extra labor for spraying is required, whereas either of the other two methods can be incorporated into present planting procedures. Gloves with a rubberized or plastic coating should be worn by persons handling the insecticide or treated trees.

Some insecticides adversely affect seedlings. For example, benzene hexachloride has been found to cause root malformation (7). It has also caused high mortality of seedlings when applied as a 2-percent spray (8). During three years of testing in the Southeast neither aldrin nor heptachlor has produced abnormal seedling mortality.

Studies were begun on weevil control in 1954 at both the Southeastern and Southern Forest Experiment Stations in anticipation of problems which might arise with the expanding cut-and-plant program in the South. These studies are yielding promising control measures to fit various conditions prior to the time that they will be needed by a large segment of the forest industry. The elimination of a long waiting period prior to establishment of pine on cutover lands promises to result in an increase in growth of a considerable volume of wood per year and substantial savings in the cost of seedling establishment.

Summary

Pales weevils are attracted to recently cut areas, and are doing heavy damage to areas planted immediately after harvest. Burning cutover areas did not effectively lessen beetle activity. Recent tests showed that the following methods of control were successful: (1) if competition is not too severe, wait at least 9 months before planting; (2) immerse tops of seedlings in insecticide prior to planting; (3) apply granular insecticide to soil around each dipped seedling; (4) spray seedlings and surrounding soil.

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Allowable Cut as a New Function of Growth and Diagnostic Tallies

L. R. Grosenbaugh
Southern Forest Experiment Station,
Forest Service, U. S.
Department of Agriculture

This article discusses: (1) the need to gear allowable cut to actual growth and ultimate levels of growing stock desired; (2) the advantage of straight line (simple interest) projection of forest stands; (3) the advantages of a new allowable-cut formula utilizing simple annual growth rates and setting forth goals and assumptions explicitly; (4) the need for permanent point-samples or plot-samples to provide feedback information; (5) and the importance of periodic coverage of all record-units by a cheap but valuable diagnostic tally primarily silvicultural in objective, but useful in crystallizing marking prescriptions and in allocating allowable cut and available funds.

ALLOWABLE CUT depends on assumptions made as to growth, on arbitrary decisions as to desired future growing stock, on the time allowed to reach growing-stock goal, and on future intensity of silviculture. However heinous extrapolation may be statistically, it is operationally necessary, but no formula can ensure a reliable projection of growth into an unknown future, nor can any formula obviate the necessity for arbitrary decisions.

There are many well-known formulae for calculating allowable cut (*5*), but most are unrealistic (they assume normality, or exponential growth rates, etc.). Many are deceptive in that they do not clearly specify assumptions, objectives, or the implications of arbitrary decisions.

Until unmanaged stands have been subjected to at least one planned harvest cut or one improvement cut, the allowable cut should not be limited by periodic growth. Now that virgin timber is largely a thing of the past in forest regions comprising the major productive area of the future, however, allowable cut must be much more closely geared to both existing and ultimately desired growing stock, to the time allowed for adustment, and to growth rates —both current rates and those expected under management throughout the adjustment period.

Compound interest is an exponential, upward-cupped growth curve well suited to describing certain economic phenomena. But it is ill-suited to describing the biological phenomenon of forest growth, which tends to be sigmoid and ultimately approaches an asymptote —behavior much more realistically approximated by arithmetic progressions (linear) than by geometric progressions (upward curving). Simple interest projects the continuous growth of forest stands — whether managed, unmanaged, even-aged, or all-aged—much better than does the compound interest favored by non-biologists. Simple interest is more consistent with the observed fact that as forest growing stock builds up, the rate of increase tends to diminish. Compound interest projections of forest stands tend to underestimate short-term growth and overestimate long-term growth, so that the projection is inaccurate except for a single, often meaningless instant of time depending on the period between past remeasurements.

The author has devised a new allowable-cut formula, based on simple annual growth percent, that states assumptions and objectives more clearly than any other he has been able to find. It is more realistic and consistent with actual forest growth phenomena than any analogs involving compound interest, and it is certainly easier to use, as no reference to compound-interest tables is needed. Simplicity and factual contact at short intervals seem preferable to complexity and unsupported long-range speculation.

The simplest situation will be discussed first, where ingrowth is inconsequential and where all classes of trees are assumed to grow at the same rate. Periodic net annual growth per acre must be measured or estimated and expressed as a decimal fraction $\left(G = \frac{\text{percent}}{100}\right)$ of the stand volume at the start of the growth period. The formula predicts the fraction of the initial stand that may be cut during a specified period.

Let n = number of years allowed between start of current period and time when ultimately desired stand will be attained.
m = number of years in shorter period for which periodic allowable cut will be calculated.
V_o = original stand volume at start of m-year period for which periodic allowable cut will be calculated.
V_n = stand residual volume ultimately desired n years hence.
V_c = volume of allowable cut for the shorter period of m years.
G = periodic net annual growth as a decimal fraction of initial stand (simple interest on V_o).

$$\frac{V_c}{V_o} = \left[\frac{1 + nG - \frac{V_n}{V_o}}{nG}\right]\left[\frac{mG}{1 + mG}\right]\left[1 + \frac{m}{2}G\right]$$

The first of these brackets is the fraction of total growth (occurring in the longer n-year period) that will not be needed to attain the desired residual stand volume V_n (if V_n is less than V_o, more than 100 percent of growth can be liquidated over the n-year period).

The second of these brackets is the fraction of the present stand which could be cut at the start of the shorter m-year period and still allow the remainder to increase to present stand volume in m years with simple net annual growth rate

$$G, \text{ since } 1 = \left[1 - \frac{1 + mG}{mG}\right](1 + mG).$$

The third of these brackets allows for the fact that cut will usually not be applied instantaneously at the start of the period, but will be spread over the period and

can be considered as being applied at mid-period, so that the average tree cut will have increased its initial volume by growth during half of the m-year period prior to cutting.

This new formula can be related to two familiar compound-interest formulae. Wahlenberg's (*6*) well-known periodic allowable-cut formula specifies that stand volume at the end of an m-year period following cutting should be the same as immediately prior to cutting, and that effective cut will be completed instantaneously at the start of the period. Under these assumptions, the first and third brackets of the new formula would each be 1, leaving $\frac{mG}{1+mG}$. Wahlenberg's formula is $\frac{V_c}{V_o}=\frac{(1+g)^m-1}{(1+g)^m}$, where (g) is the compound-interest rate for m years corresponding to a simple interest rate (G) for the same period, Hence, $1+mG=(1+g)^m$, and substituting for $(1+g)^m$, in Wahlenberg's formula gives $\frac{mG}{1+mG}$, exactly the same as the applicable portion of the new formula. However, Wahlenberg's formula must use the same m as was used in computing from growth data (failure to do this leads to erroneous growth projection); his formula assumes that cut is made instantaneously at the start of the regulatory period; and his formula makes no explicit provision for adjusting the future residual stand to some desired level in some specified period of time. The new formula has none of these disadvantages.

Meyer's (*3*, *4*) well-known annual allowable-cut formula (based on the amortizing effect of a fixed annual withdrawal on a compounding accumulation) can be written (assuming for simplicity his $g_1=g_2=g$):

$$\frac{V_c}{V_o}=\left[\frac{(1+g)^n-\frac{V_n}{V_o}}{(1+g)^n-1}\right]\left[\frac{g}{1+g}\right]\left[1+\frac{1}{2}g\right],$$

where the (g) is the compound-interest rate for n years corresponding to a simple average interest rate (G) for the same period. Hence, $1+nG=(1+g)^n$, and substituting for $(1+g)^n$ in Meyer's formula gives

$$\left[\frac{1+nG-\frac{V_n}{V_o}}{nG}\right]\left[\frac{g}{1+g}\right]\left[1+\frac{1}{2}g\right],$$

almost the same as the new formula when $m=1$. However, Meyer's formula must use the same n as was used in computing g from growth data. Despite that fact, his term $\left[\frac{g}{1+g}\right]$ will usually have a low bias, since it involves a 1-year projection based on a compound-interest rate that tends to be too low for periods shorter than n years. Furthermore, his formula makes no explicit provision for calculating allowable cut for periods longer than a year.

The new formula has none of these disadvantages, nor does it require reference to compound-interest tables. If current annual growth is zero (badly overstocked or overmature stands), the new formula no longer has meaning, but such situations are rare, uncomplicated, and easily handled by spreading liquidation out over a specified period as in Hanzlik's and Heyer's formulae (*5*).

The inability of compound interest to satisfactorily project forest growth except to one single future instant of time (involving the same period as that used in determining g) renders both Wahlenberg's and Meyer's formulae distinctly less useful than the new simple-interest formula. An internal inconsistency in Meyer's formula above (causing a low bias in the second term) occurs whenever forest growth is more nearly linear than exponential—and linear progress is almost always a better approximation of forest growth than is exponential progress.

Now that the basic formula has been presented and compared with several less desirable analogs involving compound interest, it is obvious that recognition of separate growth rates for several components and time intervals would improve it. To do this, rearrangement of the last two terms is desirable:

$$\frac{V_c}{V_o}=\left[\frac{1+nG_2-\frac{V_n}{V_o}}{nG_2}\right]\left[mG_1\right]\left[\frac{1+\frac{m}{2}G_o}{1+mG_o}\right]$$

where n = number of years allowed between start of current period and time when ultimately desired stand will be attained.

m = number of years in shorter period for which periodic allowable cut will be calculated.

V_o = original stand volume at start of m-year period for which periodic allowable cut will be calculated.

V_n = stand residual volume ultimately desired n years hence.

V_c = volume of allowable cut for the shorter period of m years.

G_o = simple periodic net annual growth rate of merchantable trees comprising allowable cut (static or slow survivor growth less corresponding mortality; no ingrowth).

G_1 = simple periodic net annual growth rate of entire stand over m-year period (all survor growth less mortality, plus expected m-year ingrowth).

G_2 = simple periodic net annual growth rate expected for enstand over n-year period, including future n-year ingrowth anticipated from various sources (such as planting), and net growth stimulation anticipated as a result of future TSI, thinning, salvage, and removal of slower-growing stems.

The term in the first bracket of the new formula is decidedly speculative, but as long as V_n is kept at least equal to V_o, this bracket cannot exceed 1, so allowable cut will not be allowed to exceed actual periodic net growth. A negative allowable cut would indicate an impossible goal—either n should be increased, or else a lesser V_n must be set as an objective.

The term in the middle bracket of the formula ordinarily sets the upper limit for allowable cut, since it represents the net growth of stems already merchantable at the start of the m-year period plus short-term ingrowth. Insofar as cut for the current period is less than growth, V_o and hence V_c for subsequent periods will tend to increase. Insofar as planted or otherwise regenerated stands make ingrowth into merchantable size, V_o

and hence V_c for subsequent periods will tend to increase. Insofar as ignored material becomes marketable, or inoperable stands become operable, or forest land is acquired, V_o and hence V_c for subsequent periods will tend to increase. Insofar as harvest cuts eliminate slow-growers or anticipate mortality, G_1 and hence V_c for subsequent periods will tend to increase. Insofar as TSI and thinning provide more growing space for residual trees, G_1 and hence V_c for subsequent periods will tend to increase. Such economic evolution or silvicultural improvement, however, should not be reflected in allowable cut for subsequent periods unless V_o or G_1 or both are observed to have increased after actual reinventory of permanent points or plots.

The last bracket of the formula merely corrects for the fact that trees comprising the allowable cut will actually be severed (on the average) somewhere near the *middle* of the *m-year* period rather than instantaneously at its *end*. If the entire allowable cut were comprised of trees overmature or likely to die during the m-year period, G_o might be zero or negative. A negative G_o, of course, would result in the third bracket's having a value larger than 1. This merely recognizes that by making the cut at the middle instead of the end of the m-year period, allowable cut will be increased by the harvest of trees that would otherwise be lost as mortality.

What if speculation as to impact of harvests, planting, TSI, thinning, etc., on future growth rate (G_2 in the first bracket) is seriously in error, because of more or less available funds than anticipated or better or poorer markets? The only effect will be that V_n will be attained sooner or later than anticipated. The allowable cut, being affected by actual feedback rather than shaky guesses, will not have permitted serious overcutting. Good forestry programs will affect allowable cut by their results, not by optimistic anticipation. Reinventory of permanent points or plots just prior to the start of each m-year period (generally 5 or 10 years) will provide not only a new estimate of V_o, G_o, and G_1, but also insight into progress toward V_n—which will allow modification of speculative G_2.

Two modified forms of the new formula are often useful in predicting the effect of a hypothetical periodic cut (V_c) on the future stand m years hence or n years hence (in the latter case, of course, each periodic cut will actually vary as periodic G_1 varies):

$$V_m = V_o(1+mG_1) - V_c\left(\frac{1+mG_o}{1+\frac{m}{2}G}\right)$$

$$V_n = V_o(1+nG_2) - V_c\left(\frac{1+mG_o}{1+\frac{m}{2}G_o}\right)\left(\frac{nG_2}{mG_1}\right)$$

A simple illustration may help to clarify use of the basic allowable-cut formula. Suppose that V_o is 100 million cubic feet, V_n desired in 30 years (n=30) is 200 million cubic feet, G_o (for slow-growing and poor-risk trees) is 1 percent annually, G_1 (for all trees now of pulpwood size or larger plus short-term ingrowth) is 4 percent, and expected G_2 for a 30-year program is 10 percent (including growth of existing stems, plus expected long-term ingrowth from submerchantable trees and planting, plus growth stimulation from thinnings, salvage and improvement cuts, and TSI). Allowable cut for a 5-year cutting budget period (m=5) would be calculated thus:

$$\frac{V_c}{V_o} = \left[\frac{1+(30)(.10)-\frac{200}{100}}{(30)(.10)}\right]\left[(5)(.04)\right]\left[\frac{1+\frac{5}{2}(.01)}{1+(5)(.01)}\right]$$

$$= \left[\frac{1+3-2}{3}\right]\left[.20\right]\left[\frac{1.025}{1.05}\right]$$

$$= \left[\frac{2}{3}\right]\left[.20\right]\left[.97^{6}\right]$$

$$= \left[.651\right]\left[.20\right]$$

= .13 (or 13 million cubic feet allowable cut in a 5-year period). Of course, board feet or basal area could be used instead of volume, if desired, and various components other than total cubic volume could be regulated.

Although the above formula seems to be more realistic and explicit as to assumptions and mechanism than classical formulae, the particular formula used is not too important. Two additional items are needed: (1) periodic unbiased net change and growth estimates from permanent point-samples or plot-samples (leading to new estimates of current G_1 and V_o); (2) periodic diagnostic tallies of temporary point-samples for each well-defined, permanently bounded record-unit or operational area.

The importance of permanent point-samples or plot-samples in estimating growth of various stand components is universally recognized and the theory, application, and advantages of permanent point-samples have been discussed elsewhere by the author (*1, 2*). However, the number of permanent points or plots needed merely for control of cutting is smaller than is commonly believed—probably 100 to 500 points or plots are ample for reasonable control, at least until the desired stocking levels have been approached.

Allowable Cut and Diagnostic Tallies

Periodic diagnostic examination of all record-units by temporary point-samples is far more important in the early stages of intensive management than either permanent growth samples or the particular formula used in computing allowable cut. Unfortunately, the need for quantitative diagnostic tallies covering all record-units once every m years does not appear

to be widely recognized, probably because the cost of such frequent coverage by conventional cruising is usually deemed prohibitive.

Conventional cruises for valuation or sales purposes have absorbed so much effort in the past that little manpower for silvicultural reconnaissance has been available. However, the detailed and precise data once needed for valuation or sale are superfluous now that harvests are being marked in advance of advertisement and sold on the basis of actual sample tree measurement. Moreover, conventional cruises, despite their expense, usually fail to provide the facts needed for silvicultural prescription or for pinpointing operational priorities.

This paper will not discuss the new and rapid technique for diagnostic tally, since it has been described by the author elsewhere (*1*). Only 16 to 25 points (tallied on a single sheet) need be visited per record-unit (an operational area ranging from 40 to 1,000 acres in size with permanent, identifiable boundaries). Ordinarily, field and office work on a record-unit can be completed in a single day. The value of a diagnostic tally for estimating need for TSI, thinning, and regeneration is obvious. Its value in preparing cutting budgets, locating record-units qualifying for a regeneration cut, and prescribing the class of trees to be marked in selected record-units seems to be somewhat less clearly understood.

In a nutshell, the allowable cut for an *m*-year period should be taken from those record-units with a maximum volume in trees harboring pathogens, trees likely to die soon, trees crowding better trees, etc. Volume in merely slow-growing or poor-quality trees on these record-units may or may not be harvested, depending on whether it is needed to make an operable cut, and whether there is other acreage better suited to or more in need of cutting. Certain classes of trees will be left where even-aged management is the goal, but taken where all-aged management is planned. The moment at which to start a cycle of regeneration cuts in even-aged management depends on whether the entire forest appears able to supply a continuous flow of record-units for cutting without recourse to seriously immature timber. Areas to be regenerated in even-aged management (subject to both volume and area control) may be intelligently selected by scanning all diagnostic tallies in the working circle. Better size-class distribution in all-aged management will be automatic where the heavier densities are allocated for cutting first. Unless the diagnostic tally can pinpoint actual record-units with enough near-static or silviculturally undesirable volume to nearly equal the calculated allowable cut, cutting should be reduced or deferred. Unless the allowable cut is comprised of trees least desirable as future growing stock, the forest manager will not progress very rapidly toward his goal of improving the quality and quantity of his sustained-yield capacity.

The salient gain from the speedy diagnostic technique is that every record-unit on a forest will be systematically (but lightly) sampled every 5 to 10 years, at which time quantitative estimates of all silvicultural needs can be made so that relative priorities among areas can be assessed and used in setting up both cutting budgets and expenditure budgets. It is easy when all the tallies are at hand to decide whether a certain type of cut in a certain record-unit would help or hinder attainment of such balance as might be desired in acreage or frequency of size-classes. Diagnostic tally volumes will usually be reasonably approximate, but more accurate estimates of cut volumes will be obtained from sample trees measured during actual marking, and it is these marked volumes that will actually be charged against the allowable cut.

With allowable cut geared to growth, and with harvests guided by diagnostic tally to areas and tree classes silviculturally in need of cutting, the cutting budget becomes a tool for favoring desirable growing stock and prescribing silvicultural measures as needed, rather than a mechanical clipping of increment on areas selected by rote.

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A Study of Aspen-Balsam Fir Cutting Methods In Northern Wisconsin—Five-Year Results[1]

John H. Cooley and
W. B. Lord[2]
Lake States Forest
Experiment Station,
Forest Service,
U. S. Department of Agriculture

ON THE BASIS of present silvicultural knowledge and relative stumpage prices, a reasonable objective in managing the aspen-balsam fir type in the Lake States is conversion to the more permanent spruce-fir type. Not only is this the natural trend of plant succession, but it usually makes economic sense, because the more tolerant spruce-fir type contains the higher valued species. The proper timing of this conversion in relation to the age of the aspen and the best way to accomplish it—whether by a single clearcutting or a series of partial cuttings—have not yet been determined.

A few basic facts about the species concerned can be used as guides. One limiting factor is the relatively low maximum rotation age for aspen. On medium sites this ranges from 30 to 45 years (*11*). Balsam fir may be held for a maximum rotation of 60 to 80 years depending mainly upon site, overhead competition, and stand density (*2*).

Balsam also has the ability to persist under overhead competition for many years, making good growth when released (*7*, *8*). It is, however, more susceptible to decay when suppressed than when growing rapidly (*9*), and its ability to respond to release seems to be more dependent on the absence of decay than on age (*6*).

With these factors in mind, it is reasonable to assume that harvesting the aspen overtopping balsam fir will be advantageous as soon as there is sufficient volume for a commercial cut even though it has not reached its maximum rotation age. Although many of the aspen trees will be unmerchantable, this early cutting would be feasible if the smaller ones could be left to attain pulpwood size without reducing the growth of the balsam understory to any great extent. If the increase in value of the residual aspen is greater than the sum of the increase in costs due to a second cutting and any loss of value-growth sustained by the balsam understory, then this early two-step removal should be preferred over a one-step removal at the same time or later.

Evaluation of cutting methods in this type, as with any type, is complicated by entomological, pathological, and climatic factors. Where the understory trees are scattered they may suffer from sudden exposure, but in dense stands they will not be so susceptible to damage (*7*). Removal of the overstory will be advantageous if it increases the growth and vigor of the understory trees, thus making them less susceptible to decay and budworm attack. Wind damage, however, could be a limiting factor because of the shallow rooting habit of balsam and spruce.

[1]Much of the material in the introduction and description of the study came directly from the work plan and establishment report prepared by J. H. Stoeckeler, on file at the Lake States Forest Expt. Sta.

[2]Stationed at Northern Lakes Forest Research Center, Wausau, Wis.

FIG. 1.—The stand before cutting, showing aspen over a fairly dense understory of balsam fir.

FIG. 2. — The stand after removal of all trees with three or more 100-inch bolts.

FIG. 3.—The stand after removal of all trees with two or more 100-inch bolts.

In the spring of 1950, a test of cutting methods in the aspen-balsam fir type was installed on the Argonne Experimental Forest in northern Wisconsin. The plots received an initial harvest cut at that time and those that were not clearcut are scheduled for a final removal cut in 1960. This report summarizes the growth on these plots during the first five years after the initial cut and cites a few of the more outstanding economic features that will influence the forest manager in his choice of cutting methods. A more comprehensive analysis, including more detailed economic evaluation, will be made after the remaining aspen overstory has been removed.

Description of the Study

The study is located in a lowland area which originally supported a stand of white pine, hemlock, and cedar. A few of the large white pine were still standing at the time the study was begun. The topography is slightly undulating, with some well-drained knolls surrounded by low moist areas. Site conditions for aspen are from medium to good, the better sites occurring on the higher land. The average total age, based on stump counts of 114 trees, was 36 years. Total height was measured on 122 dominant and codominant trees on the 25 plots included in this report; the average on individual plots varied from 45 to 69 feet. There was no significant difference between means when all plots in one treatment were averaged together. Site index at age 50 (*4*) ranged from 68 to 72 feet by treatments and averaged 69 feet for all plots.

The understory was composed chiefly of balsam fir (*Abies balsamea* [L.] Mill.) from 15 to 35 years old. A limited amount of black spruce (*Picea mariana* [Mill.] B.S.P.) occurred in the low spots, and some white spruce (*P. glauca* [Moench] Voss) on the higher areas. These understory trees ranged up to 4 inches in diameter with many under 1 inch. Scattered large balsam fir, spruce, and white pine (*Pinus strobus* L.) comprised the remainder of the stand, with white-cedar (*Thuja occidentalis* L.), red maple (*Acer rubrum* L.), pin cherry (*Prunus pensylvanica* L. f.), sugar maple (*Acer saccharum* Marsh.), and hemlock (*Tsuga canadensis* [L.] Carr.) occurring incidentally. Figure 1 shows a representative area before any cutting took place.

Merchantable volumes of aspen and paper birch were uniform by treatments ranging from 10.6 to 11.5 cords per acre and averaging 11.0 cords. Most of the understory trees were seedlings or saplings not yet merchantable.

Total basal area of all trees 1.6 inches d.b.h. and over ranged from 79 to 125 square feet per acre on individual plots, with an average of 99 square feet. Aspen and paper birch basal area was from 60 to 95 square feet, averaging 74; and balsam fir plus spruce basal area varied from 8 to 43 square feet, averaging 24. The basal area of balsam fir and spruce varied from 9.8 to 39.1 percent by individual plots and averaged from 22.4 to 29.2 by treatments. Aspen and birch, then, averaged approximately three-quarters of the total basal area.

A description of the treatments used follows:

Check: No treatments.

Clearcut: All aspen and birch removed, regardless of diameter.

Cut from below: A light thinning from below which removed about 10 percent of the merchantable volume, mostly in 1-stick trees. No trees having less than 1 pulpwood stick, and very few 2-stick trees, were cut. Remaining aspen and birch is to be cut in 1960.

Cut from above: All aspen and birch having three or more pulpwood sticks were cut. Remaining aspen and birch is to be cut in 1960.

Commercial clearcut: All aspen and birch having two or more pulpwood sticks were cut. Remaining aspen and birch are to be cut in 1960 if operable volume is reached.

To be clearcut, 1960: All aspen and birch to be removed in 1960, regardless of diameter.

The study area was divided into five replication blocks, four of which are fairly compact. The fifth block was broken into three separate areas so that it would be more homogeneous before the initial cut. Six plots, one for each treatment, were laid out within each replication block. The plots were 2.5 chains square (⅝ acre). Treatments were assigned at random to plots within blocks. Growth and cut data were taken on 1/10-acre circular plots located at or near the center of each square plot.

Time Required for Cutting and the Residual Stand

The initial cut was made by a commercial operator during the spring of 1950. This operator cut only trees that he considered merchantable. On the plots cut from below, and on the clearcut plots, some marginal and unmerchantable material was removed after the main cutting operation.

Cutting, peeling, and swamping time was high for all treatments compared to the time required in pure stands (*1*). This was due partly to the low volume per acre harvested, and partly to the presence of a dense understory which hampered the movements of the cutters. Cutting from below required 9.3 man-hours per cord for cutting, peeling, and swamping, compared to 5.0 and 5.5 man-hours per cord for the commercial clearcutting and cutting from above respectively. Not only was less volume removed in the cut from below, but the sticks harvested were of much smaller average size. On the plots which were completely clearcut, time required to remove unmerchantable material brought the total requirement per cord to 7.1 manhours, making the cost per cord of salable material high for this type of cutting also.

Figure 2 shows a plot after removal of all trees with three or more 100-inch bolts. Note that the stand appears to be reasonably fully stocked with good aspen even though 65 percent of the merchantable volume has been cut. Figure 3 shows a plot which received a commercial clearcutting. This treatment, which removed 93 percent of the merchantable volume, left only a few overstory aspen trees of poor crown development. These photographs illustrate the middle range of cutting methods tested. Complete clearcutting left no overstory, and cutting from below removed very little of the overstory.

Five-Year Growth

Five years after the initial harvesting operation, the growth plots were remeasured to determine the effect of the various treatments. To evaluate these treatments, it is necessary to discuss the effects on the two separate components of the stand, and to have these components well defined. For clarity, the aspen, paper birch, and other hardwoods are referred to as the overstory, and the spruce, balsam fir, and other conifiers are considered the understory. Some individual trees are incorrectly classified on this basis, but the separation between overstory and understory is generally along these species lines.

Differences in total production of merchantable volume in the overstory to 1955, as shown in Figure 4, have an apparent trend which is clearly related to the percentage of volume cut in 1950.

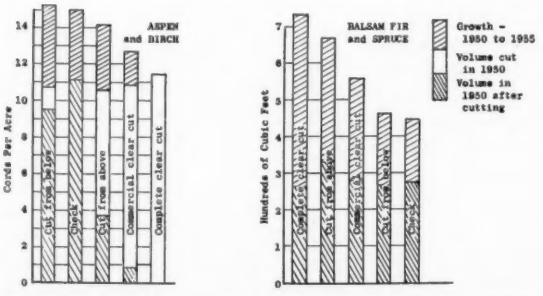

FIG. 4. — Average volume and 5-year growth by treatment. Cordwood volume is for aspen and birch trees over 4.5 inches d.b.h. to a 4-inch minimum top. Cubic-foot volume is for balsam fir and spruce trees over 1.5 inches d.b.h.

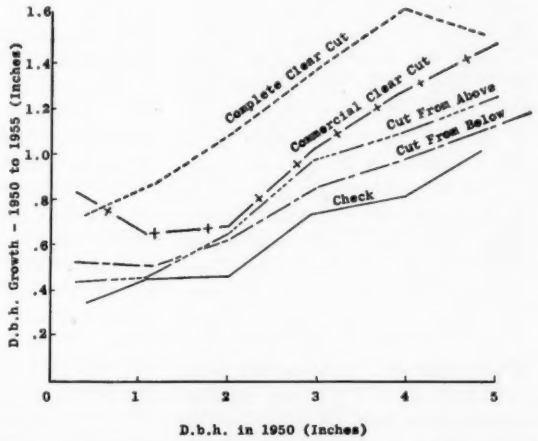

FIG. 5.— Average 5-year diameter growth of understory balsam fir.

The heavier cuttings from above which removed more than 50 percent of merchantable volume have decreased total production, while the light thinning from below has apparently increased the total production slightly. The differences between treatments are not statistically significant, but the reduction in total yield on the plots that were cut from above is consistent with previous investigation. Heinselman (*3*), working with medium-site aspen, found that early partial cutting in the upper crown classes, which removed less than 50 percent of the stand, reduced total yield by 2.9 cords over a 42-year rotation. It is logical to expect that this effect would be even more pronounced by heavier cuttings.

In contrast, the total production of the understory in terms of total cubic feet in trees 1.6 inches and up (Fig. 4), has increased as the volume removed from the overstory increased. The mean cubic-foot volumes of the understory for each treatment were not significantly different in 1950 before cutting, but by 1955 the mean volumes for all treatments except the cut from below were significantly higher than on the uncut plots.

As a further measure of the effect of each method of cutting upon the understory, the diameter growth of the balsam fir was analyzed. These data are shown in Figure 5. Below the 2-inch diameter class the means shown on this graph are based on approximately eight trees on each plot or about 40 trees for each treatment. For the 2-inch class and above, the data are based on all the trees on the growth plots. The same general relationship appears in these data as for cubic-foot volume. One exception is the cut from above, which fell below the commercial clearcut in all but the 2-inch class. This apparent discrepancy between diameter growth and volume growth may be explained by the larger number of trees on the plots cut from above (614 per acre as compared to 494 per acre on the plots which sustained a commercial clearcut) and by the superior height growth of the trees on the plots cut from above. Height growth of sample trees in the understory was analyzed, but trends and relationships exhibited were not clear enough to have much bearing on the overall evaluation.

A further discrepancy in Figure 5 appears below the 2-inch diameter class. Apparently these smaller trees are being suppressed by overtopping balsam and spruce as much as by the higher overstory of aspen, so that their response to cutting in the overstory is not so definite as is the response of the larger trees.

The overall result of these opposing effects upon overstory and understory has been very small differences in total cubic-foot production of the entire stand. The heavier cuttings, which reduced the total yield of aspen, have stimulated the growth of the understory enough to nearly make up for this reduction. The total yield of the entire stand will therefore not be greatly reduced by early cutting, as long as the understory itself is dense enough to occupy the site. The effect of the heavier cuttings has been to shift the growth from merchantable overstory trees to the nonmerchantable understory trees.

No substantial mortality losses have occurred since 1950 in either the understory or the overstory. Hypoxylon canker infection was present in the stand at that time but did not increase significantly after cutting.[3] The incidence of other diseases and of insect attacks has been of no importance.

Since spruce-fir stands have been shown to be susceptible to wind damage after partial cutting (*5*), this factor will have a bearing on the management of the aspen-balsam type. However, this study will furnish no information on the effect of cutting methods on wind damage, because of the small size and arrangement of the plots. It is possible that wind will not be a limiting factor until the understory is thinned, but the more promising cutting methods must be tried on larger areas before a positive statement can be made.

[3]Sample trees were examined for hypoxylon infection in 1950 and 1955.

Discussion

The objectives of the owner will have large influence on management practice in the aspen-balsam type. Early cutting of the aspen and birch is likely to reduce the total production from the overstory, unless the cutting is done as a thinning from below. On the other hand, the understory will benefit from any degree of release, up to and including complete removal of the overstory.

At the present time, the market value of balsam fir pulpwood substantially exceeds the value of aspen pulpwood. Latest price quotations available show rough balsam fir pulpwood at the mill bringing from $6 to $12.50 per cord more than rough aspen (*10*). For the owner whose principal interest is maximum return from his land, early release of the balsam understory such as resulted from the commercial clearcut would appear to be the most logical course of action, even at the expense of reduced production from the overstory.

Complete removal of all overstory trees will stimulate the understory to maximum growth, but its economic justification is questionable. The data are as yet insufficient for an accurate comparison between this complete removal of the overstory and removal of only merchantable trees. Preliminary results, however, indicate that any return attributable to the removal of nonmerchantable aspen is too far in the future to justify the extra cost and the subsequent loss of growth in the overstory that would inevitably result.

Pulpwood operators have found that the break-even point in aspen, at which conversion costs are just returned, generally occurs between the 1-stick and 2-stick trees. Cutting to this point is exemplified in the study by the commercial clearcutting treatment, which removed all trees in the overstory that were considered by the operator to be merchantable. It resulted in a significant increase in understory

FIG. 6.—All trees having two or more 100-inch bolts were removed from this stand seven years earlier.

FIG. 7.—All trees having three or more 100-inch bolts were removed from this stand seven years earlier.

growth, and, if growth of the overstory during the past five years can be projected for the next five years, there will be sufficient volume for an operable cut in 1960. This cut will probably be of rather low quality, but it will furnish an opportunity for some thinning in the understory. Figure 6 shows a plot in the winter of 1958 from which all 2-stick and larger trees were removed in 1950.

The paper mill owner who depends upon aspen for his main source of raw material will probably not want to reduce the potential production of this species by an early removal cut. There is little he can afford to do, however, to halt the natural successional trend, so that the next generation will undoubtedly be largely balsam fir. He might attempt to increase the total production of aspen during the present generation by thinning the overstory from below. The costs of such a thinning operation are usually high because of the small volume per acre of relatively small material removed. Whether this high cost will be offset in the final harvest cannot yet be predicted from the results of this study. An alternative, however, is to thin the stand from above, removing more volume of larger material. Total production of merchantable volume appears to be only slightly reduced by this type of cutting, and in this study it has effected nearly as much understory release as the commercial clearcut. At the same time, the harvesting costs for such an operation were not much higher than for commercial clearcutting—5.0 man-hours per cord for the latter compared to 5.5 man-hours per cord for cutting from above. This procedure appears to have much to recommend it, especially for the owner interested in maintaining a high yield of aspen and birch, and releasing the understory trees before it is too late for them to respond satisfactorily. Figure 7 shows a plot in the winter of 1958 from which all 3-stick and larger trees were removed in 1950.

It should be understood that the stand in which this study is located is not typical of all areas that have aspen and birch over balsam fir and spruce. The understory in aspen-balsam fir stands will range from a few scattered trees up to the dense understory typified by this study. The recommendations made in this report must be modified to meet these varying conditions. It is obvious that the conversion of aspen and birch on some sites will require more than two cuttings. In fact, it may be that aspen and birch will be the main components of the next stand on some areas, and natural conversion will be a gradual process involving several harvest cuttings. The same principles, however, apply to any of these stands where balsam fir is the main understory tree; that is, balsam fir will respond vigorously to release. Since it is more susceptible to decay when suppressed than when growing rapidly, the small trees should be released as soon as practicable. It is seldom necessary or desirable to remove all overstory trees whether merchantable or not, but the loss of some growth in the overstory, occasioned by cutting before rotation age is reached, is usually justified.

Summary

During the spring of 1950 a

study, designed to evaluate various methods of cutting in aspen stands with balsam fir understories, was installed in northern Wisconsin. The stand selected had an overstory of aspen and paper birch averaging 36 years of age, and a balsam fir, white spruce, and black spruce understory that varied from 15 to 35 years of age. The overstory, mostly aspen, made up approximately three-quarters of the total basal area prior to the initial cut.

Four treatments and a control were replicated five times using 0.625-acre square plots. The treatments were: (1) a complete removal of all aspen and birch, (2) removal of all aspen and birch with two or more pulpwood sticks, (3) removal of all aspen and birch with three or more pulpwood sticks, and (4) removal of mostly 1-stick aspen and birch with occasional 2-stick trees. For simplicity of presentation, these are referred to in this report as: (1) clearcut, (2) commercial clearcut, (3) cut from above, and (4) cut from below. In addition, a series of plots were set up to be clearcut in 1960.

Final evaluation of the study is not attempted in this report; however some results have been obtained which allow preliminary appraisal of the cutting methods studied.

Commercial clearcutting.—Commercial clearcutting increased the growth rate of the understory trees, although the stimulation was not as sharp as that of complete release. Growth in the residual overstory, however, will make possible an operable cut in the near future. The presence of this residual aspen will make it possible to combine an early thinning in the understory with a commercial operation. For this reason it is to be preferred over complete clearcutting.

Cutting from above.—Cutting from above was nearly as effective as commercial clearcutting in releasing the understory, yet it did not reduce the total production of merchantable volume as much as commercial clearcutting. Although the largest trees were cut, the residual overstory has grown well, and there will be ample volume for a second cut when it seems most advantageous. This treatment appears to be achieving the objective of maximum early understory release consistent with minimum reduction of total yield from the overstory.

Cutting from below. — Cutting from below did not remove enough of the overstory to effectively release the balsam fir, and harvesting costs for the initial cut were much higher than for other cuts which removed only merchantable trees. For these reasons, it cannot be recommended as sound management procedure in the aspen-balsam type.

Complete clearcutting. — Complete removal of the overstory resulted in the greatest stimulus to the understory. However, when the extra cost of removing marginal and unmerchantable trees and the loss of growth on these trees are balanced against the additional understory growth, it is doubtful that this complete release is feasible.

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Soil Temperatures During Burning Related to Postfire Seedbeds on Woodland Range

J. R. Bentley
and R. L. Fenner
California Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture[1]

AFTER WOODLAND RANGE is burned, land managers need some way to recognize the suitability of the postfire seedbed for artificial seeding. Seedbed conditions are likely to vary widely because of variations in fuel and burning conditions. Where sufficient fuel is burned and the soil surface becomes hot enough to kill seeds of plants that would compete with sown forage species, sowing will have a good chance of success. Where there is little fuel or it is not consumed by a hot fire and seeds of competing plants are not killed, artificial seeding will be a waste of money.

Range managers have learned that brush burns which leave a conspicuous whitish ash over most of the burned area usually destroy most seed of competing plants. But the ash may disappear by the time of sowing. Or it may cover only part of the ground surface.

To provide a wider range of criteria than the presence or absence of white ash, we classified seedbeds in four groups by the appearance of the soil surface after burning. One is the grass-burn seedbed, which is found where fire burned through grassy openings. The other three are brush-burn seedbeds, defined as follows:

Black-ash, where leaf litter was thoroughly charred but not consumed.

Bare-soil, where litter was consumed.

White-ash, where heavy pieces of wood were consumed.

Then we measured soil temperature during burning of various fuels on woodland range in the Sierra Nevada foothills. By relating the temperatures to postfire seedbed classes, we were able to redefine the seedbed classes and set up criteria which should be widely useful.

Methods

The test was conducted in a controlled burn at the San Joaquin Experimental Range in September 1952. The 200-acre burn was in open woodland type with interspersed thickets of trees and shrubs. Some of the shrubs had been smashed with a bulldozer in preparation for burning. The herbaceous cover in the openings was composed of annual plants.

Records of soil temperatures during burning were made at 19 locations inside the fire perimeter. The locations were selected to include the range of fuels which typically occur within the woodland type. At each two or more pyrometer records were made.

A total of 20 records was obtained under the fuels found in grassy openings between brush thickets. These light fuels varied from thin to thick stands of grasses and forbs. Most of the litter on the soil surface was from herbaceous plants, but leaves from trees or shrubs were included at some stations.

A total of 24 records was obtained under fuels found within stands of trees and shrubs. These fuels varied greatly in quantity, from small shrubs to heavy logs. At some stations the shrubs were upright, at others they had been smashed flat. There was a layer of leaf litter at most stations.

The soil pyrometer used in this test[2] was designed by Fenner to record the maximum depth at which any one of 10 specific temperatures occurred within the surface litter and upper 2 to 3 inches of mineral soil. The pyrometer consisted of a very thin mica plate, 2 inches wide and 3 inches high, on which 10 different fusible compounds had been painted, each in a single vertical strip. The specific melting points for the different compounds, in degrees Fahrenheit were: 150, 200, 250, 350, 450, 550, 650, 750, 950, and 1,150. The face of the mica sheet, on which the strips were painted, was covered with a thin piece of asbestos paper. The pyrometer was inserted into the ground with a special tool so that the back of the mica sheet was packed tightly against an undisturbed soil profile. The top of the sheet was placed approximately flush with the surface of the litter layer, or flush with the mineral soil surface if there was no litter.

Physical appearance of the area surrounding each pyrometer station was described and photographed before and after the fire, and any factors which might influence the temperature of the soil during burning were noted. After the fire, a 1-foot-square quadrat surrounding the pyrometer was classified according to seedbed condition. Before each pyrometer was removed from the soil, the level of the mineral soil surface was marked as closely as possible on the mica plate. The maximum depth below mineral soil at which each of the 10 temperatures had been recorded, as indicated by melting of the fusible compounds, was measured on each mica plate. In January 1953, notes were made on germination of herbaceous plants in the square-foot quadrats at each pyrometer station.

[1]Maintained at Berkeley, California, by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

Mr. Bentley is range conservationist and Mr. Fenner is former range conservationist at the station.

[2]Fenner, R. L., and J. R. Bentley. A simple fusion pyrometer for measuring maximum soil temperatures during wildland fires. (Manuscript submitted to Forest Science.)

Results

The temperatures recorded at specific depths have been summarized in graphic form for grass-burn seedbeds (Fig. 1) and for brush-burn seedbeds (Fig. 2).

The characteristic penetration of heat during burning is shown for each seedbed class as a curve which cuts through the median temperature interval recorded at each specific depth in the litter and in mineral soil. At any depth the temperature was recorded within an interval of either 50° or 100°F. For example, the interval was 150-200°F. at a given depth if the 150° compound was melted and the 200° compound was not melted at that depth. Or, if the 350° compound melted and the 450° compound did not, the interval was 350°-450° F. The median interval at a specific depth for a seedbed class was the interval having approximately an equal number of records above and below it. In most cases, the median was also the interval containing the greatest number of individual records.

The extreme limits of temperature recorded at each depth are also shown in the graphs for grass-burn seedbeds and for brush-burn seedbeds. In most cases, the extremes represent records from only one or two of the pyrometer stations within the seedbed class.

Grass-burn seedbeds.—The grass-burn seedbed was recognized by the black, charred remnants of plants left on the ground after fire had swept through light herbaceous fuels. There was a light dusting of greyish ash from incinerated herbage visible immediately after the fire but this soon disappeared. The dead annual plants usually were burned to about a ¼-inch stubble. A thin layer of uncharred herbaceous litter on the soil surface often remained after the fire.

The fire travelled fast in these light fuels and did not consume all the litter. Consequently temperatures measured during the fire were relatively low at and below the soil surface. Where the prefire litter was thin, temperatures at the mineral soil surface were typically in the 200°-250° interval; at 1 out of 14 stations the temperature was greater than 250° and at 3 stations it was less than 200°. A temperature in the 200°-250° interval was recorded slightly into mineral soil at only 3 stations; at 7 stations the temperature in the mineral soil was in the 150°-200° interval, and at the other 4 stations it was less than 150°.

Where litter was deeper than 0.4 inch, temperatures greater than 200° occurred only in the upper part of the litter. At 5 out of 6 stations the temperature was less than 150° at the mineral soil surface.

From laboratory studies, Sampson[3] reported that most dry seeds

[3]Sampson, Arthur W. Plant succession on burned chaparral lands in northern California. Bul. 685, March 1944, Univ. of Calif., Berkeley, Calif. 1944.

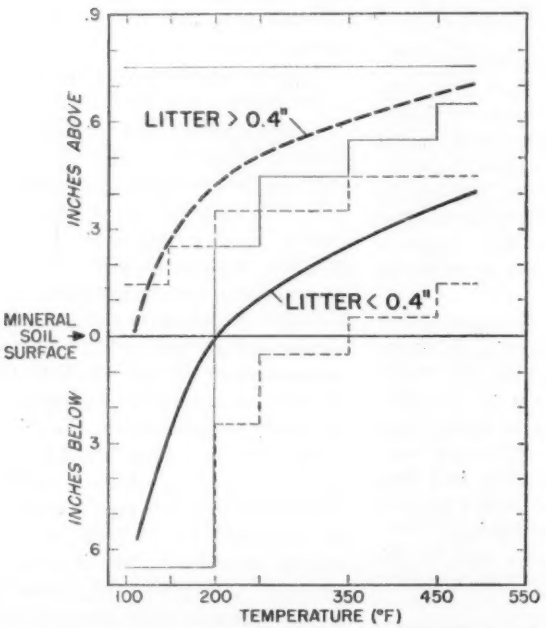

FIG. 1.—Heat penetration during burning of grass fuel where litter was greater than 0.4 inch and less than 0.4 inch. Heavy lines indicate median temperatures and light lines are extremes that were recorded.

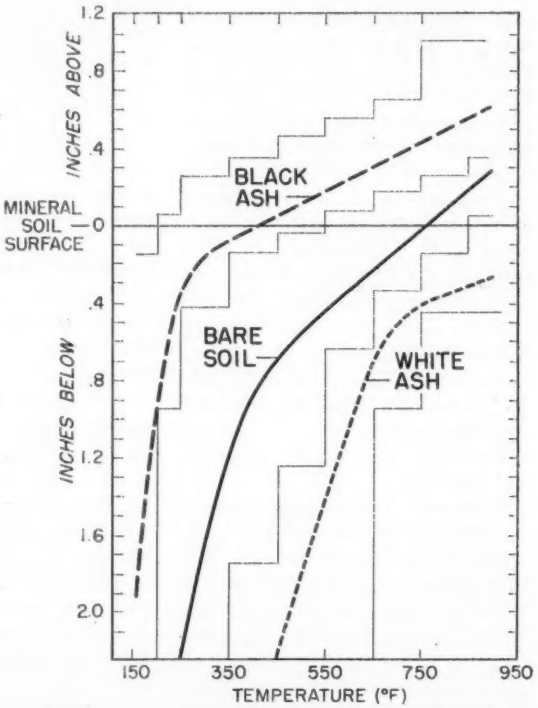

FIG. 2.—Heat penetration during burning of brush fuel for three postfire seedbeds: black ash, bare soil and white ash. Heavy lines indicate median temperatures and light lines indicate extremes within which most records fell.

will be killed by 5 minutes exposure to temperatures of 250° to 300°F. This temperature interval was recorded at the mineral soil surface at only 1 pyrometer station in a grass-burn. Also, the heat was of short duration in the grass-burn. Measurements with thermocouples[4] would indicate that maximum soil temperatures during burning of grass are held for considerably less than 5 minutes. Assuming that temperatures of 250° to 300° are required to kill most seed under field conditions, a grass fire would have little effect on the survival of seed located at the mineral soil line or in the mineral soil.

The pyrometer records indicated, however, that seed located in the upper part of the litter and seed still on the stalks would be destroyed in a grass-burn. Seed in the upper litter would be charred by temperatures above 350°, and seed above the litter would be subjected to even higher temperatures. Grass seeds apparently are more apt to be damaged by fire than are seeds of many forbs. Repeated observations made during the first year after a grass burn on foothill range show a reduction in density of grass and a dominance of filaree, the seed of which is buried in the soil where lethal heat does not penetrate. A fire soon after maturity and drying of grass, before seed has shattered or while it is still on top of the litter, would have the greatest effect in reducing stands of annual grasses.

Although numbers of plants were reduced, sufficient herbaceous plants were established to produce a thick stand during the year following a grass fire on foothill annual-plant range. Observations at the pyrometer stations in January 1953 showed 100 to 500 seedlings per square foot in the grass-burn. This is a marked reduction from the usual number on unburned grassland but is still more than adequate. The greatest foliar density of seedlings occurred in the quadrats with a thick pre-fire litter.

[4]Craddock, George W. The *successional* influence of fire in the chaparral type. Masters thesis, Univ. of Calif., Berkeley, Calif. 1927.

We can conclude that grass burns are poor seedbeds for broadcast sowing of introduced forage species because of excessive competition from surviving resident annuals and because there is no mellow soil to cover the seed.

Brush-burn seedbeds.—In contrast, temperatures sufficiently high to kill dry seed were recorded at the soil surface and into the mineral soil where brush burned. The characteristic depth of heat penetration, however, was distinctly different for black-ash, bare-soil, and white-ash seedbeds (Fig. 2).

A wide range of soil temperatures during burning was recorded in mineral soil within brush-burns. Most of the records for a seedbed class fell within its range as shown in Figure 2, with a transition occurring from the lightest to the hottest burn. The recorded temperatures at several pyrometer stations, however, were outside of the expected range.

1. Black-ash seedbed. A black-ash seedbed was recognized by a cover of charred leaf litter and was so named because of common use by ranchers. It occurs where heat radiated from burning brush has not been sufficient for incineration of the poorly aerated litter fuel. Some greyish ash, from burning part of the litter and brush twigs, was present immediately after the fire but soon became inconspicuous.

Temperatures considered sufficient to kill dry seed were recorded near the soil surface at most pyrometer stations in the black-ash. Temperatures at the soil surface were above 350° at 7 of the 10 stations on this class of seedbed. For 6 stations at a depth of 0.3-inch in mineral soil, the temperature was above 250°. At 3 stations which were classed as black-ash seedbed because some charred material remained on the soil surface, the recorded temperatures at all depths were greater than expected. The depth of charring of organic matter in the soil indicated that the stations would have been better classed with the bare-soil seedbeds.

As would be expected from the variations in heat penetration recorded in black-ash seedbeds, establishment of herbaceous plants the year after the fire was also variable. In January 1953 there were no plants in the 3 quadrats located at the pyrometer stations where temperatures had been above the expected range. In 2 other quadrats there were 6 to 10 plants per square foot. In each of the other 5 quadrats there were 35 to 82 plants. At 3 of these 5 stations most of the plants were from seed buried at depths of 0.5 to 1.0 inch, below the depth at which killing temperatures were recorded. Some of the herbaceous plants found on black-ash seedbeds may have grown from seed moved in from adjoining grass burn. Pyrometer stations were often within 1 or 2 feet of a grass burn because black-ash seedbeds occurred at the periphery of individual shrubs consumed during the fire.

Because the stand of competing resident plants is typically thin and spotty, the black-ash seedbeds are fair for broadcast sowing of introduced forage species, particularly aggressive annuals. Sowing promotes heavier herbage production the first year and increases competition with new brush seedlings, which often are numerous on seedbeds of this sort. But, a good stand of annual species will be established naturally within 2 or 3 years even if the areas are left unsown. This natural cover usually is sufficiently dense and continuous for a satisfactory reburn to kill brush seedlings.

2. Bare-soil seedbeds. Bare-soil seedbeds occurred where the fire had been sufficiently hot to consume the leaf litter and fine woody material on the ground surface. Some charred material commonly remained but it was very sparse.

Immediately after the fire the ash from incinerated litter and sticks is generally rather conspicuous, but most of it may soon disappear. At the time of sowing therefore this kind of seedbed has a barren soil aspect.

Temperatures above 250°, the lower limit for killing dry seeds, were recorded to a depth of at least 0.3 inch at each of the 11 pyrometer stations in this seedbed class. At 3 stations this was the limit of heat penetration; the records fell just inside the range expected for black-ash instead of bare-soil seedbeds. At the other 8 stations the temperature was above 550° at 0.3-inch depth, and 250° was recorded to a depth of 1.0 to 2.0 inches. At these 8 stations, temperatures above 350° were recorded to a depth of 0.5 to 1.0 inch or deeper. This temperature range was sufficiently high for charring of the organic material within the mineral soil layer. The presence of this definite layer of blackish charred soil 0.5- to 1.0-inch deep proved to be a typical characteristic of the bare-soil seedbed.

The highest temperatures recorded at different depths fell within or only slightly above the range indicated for bare-soil seedbeds in Figure 2. Where temperatures were above 700° in the mineral soil, there apparently was insufficient oxygen for complete combustion of the organic material except at the soil surface.

As would be expected from the usual high temperatures at the soil surface and in the mineral soil, few herbaceous plants were established on the quadrats classified as bare-soil seedbeds. In January 1953 there were no herbaceous plant seedlings on 4 of the 11 quadrats. On 2 quadrats there were 7 and 11 seedlings which came from seed buried below 1-inch depth, in a zone where temperatures were not sufficient to kill the seed. On each of the other 5 quadrats there were from 3 to 18 seedlings, mainly forbs. The source of seed on these quadrats was not determined. Some of the seed may have been deeply buried; the remainder may have come from outside sources or from portions of quadrats where heat did not penetrate because of rodent disturbance before the fire.

The bare-soil class is an excellent seedbed for broadcast sowing of introduced forage species, both perennials and annuals. The soil surface is loose and mellow for covering the broadcast seed, and there will be little competition during the first year from the thin stand of resident annuals. Without artificial sowing, several years may be required for establishment of a continuous stand of herbaceous plants.

3. White-ash seedbed. White-ash seedbeds were recognized by a layer of fluffy ash where large branches or main stems of trees or shrubs had been consumed by fire. This layer of ash may be somewhat compacted at the time of sowing and much of it may disappear, but the outline of the original location can still be seen. The white-ash seedbed, as here defined, is ordinarily very limited in total area on a brush burn at the time of sowing. It is most extensive where dense stands of heavy brush have been burned to stubs.

Only three pyrometer stations were located on white-ash seedbeds where large smashed shrubs or old dry logs were consumed during the fire. At each station temperatures sufficient to destroy all seed were recorded to the full depth of the pyrometer. The range in recorded temperatures was approximately the same as shown for this seedbed class in Figure 2.

A characteristic of this seedbed is the complete incineration of organic matter in the upper mineral soil to a depth of at least 0.25 to 0.5 inch. Temperatures were above 650°, and at one station above 1,150°, within this zone. Apparently the source of heat exists long enough for incineration even though oxygen supply in the soil is at a low level. Temperatures in the incinerated zone are sufficient to alter the collodial structure of the soil. Incineration into the soil is recognized by a layer of light colored, usually reddish, soil. This is underlain by a dark layer where the organic matter has been only charred.

Grass seedlings were found in January on two of the three quadrats on white-ash, but these plants definitely were from surface seed which had moved onto the quadrats after the fire. Because of the naturally barren condition, spots of white-ash seedbed should be artificially revegetated along with bare-soil seedbed which makes up most of the area on a hot burn.

Summary and Discussion

Simple fusion pyrometers proved satisfactory for measuring soil temperatures during burning of different fuel types on woodland range. Variations in temperatures between pyrometer stations, however, emphasize the need for a large number of individual measurements. This information is required for full understanding of the effects of burning on plant succession. More field records are also needed as a basis for designing laboratory techniques to stimulate soil-temperature conditions which actually occur within burns.

Postfire seedbed classes as previously defined from appearance of the soil surface after burning were shown to be closely related to soil temperatures during burning. Each class had a characteristic pattern of heat penetration into the soil. This study indicates, however, that depth of charring and incineration within the mineral soil are better criteria than soil-surface appearance in classification of seedbeds. A suggested classification for brush burns is as follows:

SURFACE-CHAR SEEDBED. Charring extends slightly into mineral soil. Usually there is a thin cover of charred leaf litter on the surface.

SOIL-CHAR SEEDBED. Charring extends 0.5 to 1.0 inch or deeper into mineral soil. Most or all of litter is incinerated, giving an appearance of bare soil after the light ash disappears.

SOIL-INCINERATION SEEDBED. A lightish incinerated zone extends 0.25 to 0.5 inch or much deeper into mineral soil, with a charred zone below. A layer of ash is on the soil surface.

Composite Aerial Volume Table for Southern Pines and Hardwoods[1]

Gene Avery
Southern Forest Experiment Station,
Forest Service,
U. S. Department of Agriculture

AERIAL PHOTOGRAPHS are commonly used by southern foresters for mapping types, measuring areas, and organizing ground inventories. Opportunities for estimating timber volumes directly from aerial photographs are restricted, however. Because the 1:20,000 panchromatic photographs ordinarily available offer minimal tonal contrast between pines and hardwoods such species groups are not easily separated for making photo measurements.

This study was undertaken to construct and test a composite aerial volume table that could be used independently of species. Field work was organized so that data for future regional tables might be collected on the Southern Forest Survey.[2]

Itawamba County, in northeast Mississippi, was selected as the study area because the predominant forest cover is a mixture of shortleaf-loblolly pines and upland hardwoods. Fifty 1-acre circular photo-plots, distributed throughout the county, were located on stereopairs of 1:20,000 USDA panchromatic photographs taken during the growing season. Each plot was visited in the field and the gross cubic volume determined by point-sampling.[3] To sample all stand conditions within the acre and allow for possible non-coincidence of photo and field locations, tree tallies were made at the plot center and at four satellite points 80 feet away. Stand volume per acre on each plot was taken as the average of the five tallies.

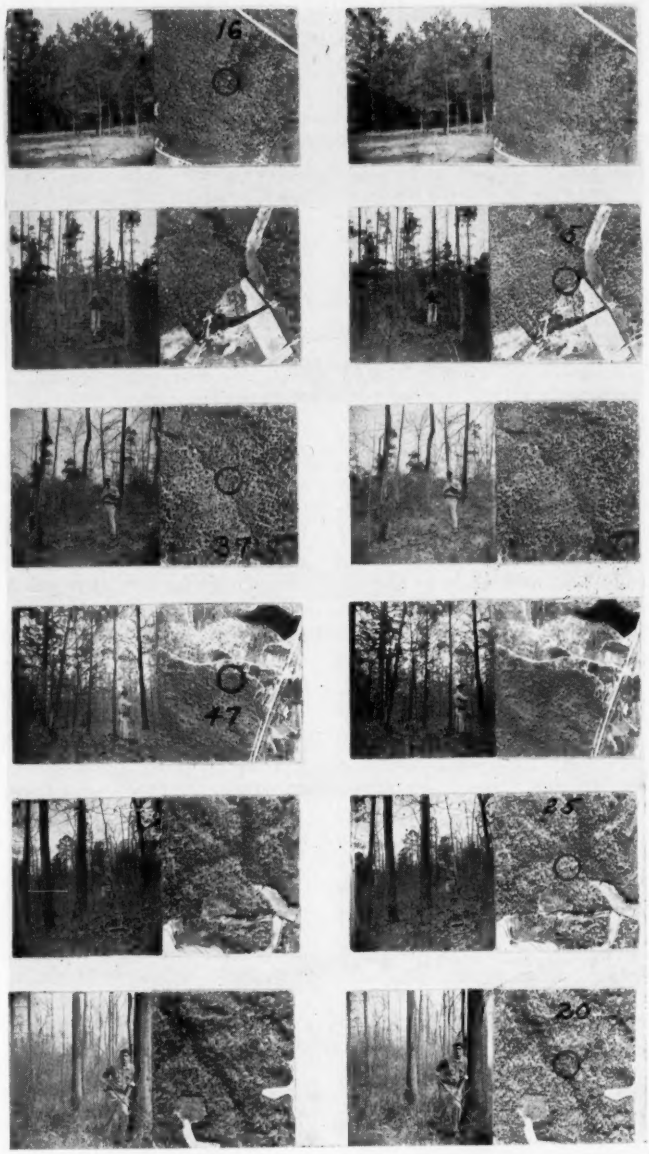

FIG. 1.—Ground and aerial stereograms for six test plots in Itawamba County, Mississippi. Aerial photo scale is 1:20,000. Circle size: one acre.

At each field location, six to eight individual trees were measured for d.b.h., merchantable and total height, crown diameter, and Girard form class. A total of 348 pines and hardwoods, 5 inches d.b.h. and larger, were thus sampled. An ocular estimate of crown closure percent was made, and 35 mm ground stereograms were taken for comparison with 1:20,000 vertical photographs. Several corresponding pairs of ground and aerial stereograms are shown in Figure 1.

[1]Based on a portion of a thesis submitted to the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June 1958.

[2]The Southern Forest Survey is a periodic inventory of the forests of the Midsouth, conducted by the Southern Forest Experiment Station, New Orleans, La.

[3]Grosenbaugh, L. R., and W. S. Stover. Point-sampling compared with plot-sampling in southeast Texas. For. Sci. 3:2-14. 1957.

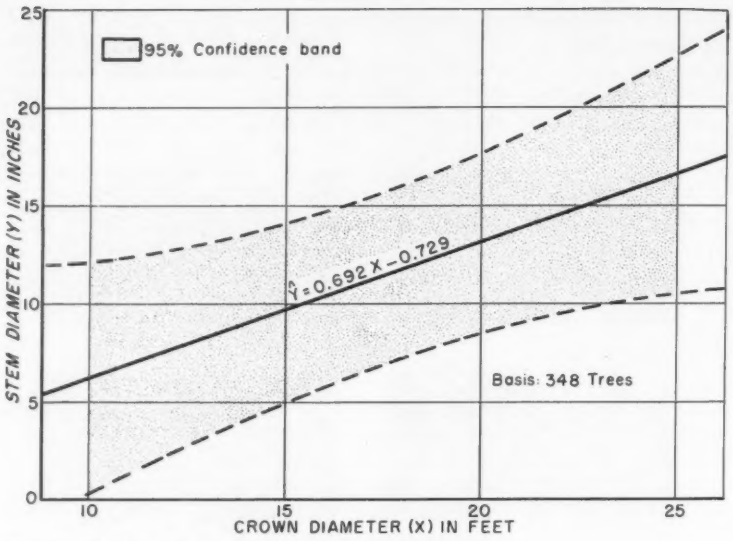

FIG. 2.—Relation of stem diameters to crown diameters.

Volume Table Construction

Stem and crown diameter measurements for the 348 trees were plotted on cross-section paper, with crown diameter as the independent variable (X) and d.b.h. as the dependent variable (Y). A linear relationship was indicated, and a regression of the form $y = a + bx$ was fitted to the data by the method of "least squares." The resulting prediction equation is graphed in Figure 2.

The "F" test showed the regression to be significant at the 1 percent level. The prediction equation was then used to obtain average d.b.h. values for crown diameter classes of 10, 15, 20, and 25 feet (the range encountered in the study area). By entering form class volume tables[4] with these average d.b.h. values, cubic volumes of individual trees, by 10-foot total height classes, were obtained. Form class 77 was used, as it represented an average for all trees tallied.

To convert individual tree volumes into an aerial stand volume table, it was necessary to determine the average number of stems per acre by crown diameter and crown closure classes. These calculations were based on the premise that tree crowns in the study area tended to occupy areas approximately the squares of their average diameters.[5] A 10-foot crown therefore had an effective closure area of 100 square feet; a 15-foot crown, 225 square feet; and so on. By dividing the crown area of the average tree into the total crown area available at 10 percent closure intervals, the average number of trees per acre was determined. Calculations are summarized in Table 1. Although this method of determining crown area may be applicable only in certain regions, it appeared reliable for forests in Itawamba County.

From Table 1, numbers of trees per acre for each crown diameter and crown closure class were multiplied by average cubic volumes per tree to obtain gross stand volumes per acre. Values were rounded to the nearest 10 cubic feet. The resulting composite aerial volume table (Table 2) was first entered with the average crown diameter of the stand; then average total height and crown closure percent were used to determine cubic volume per acre.

Accuracy of the Table

To ascertain how well the volume table agreed with stand conditions in the area of construction, it was desirable to make a comparison free from errors of photo interpretation. Though the composite table was compiled from measurements of individual trees rather than from gross plot data, ground measurements of average stand height, average crown diameter, and crown closure percent had been made on each of the 50 test plots. By entering the composite table with these variables, bias-free plot volumes were obtained. Values thus derived from the table ranged from 190 to 1,740 cubic feet per plot, while corresponding field volumes varied from 144 to 1,732 cubic feet. Average volume per acre as determined from the table was 613.6 cubic feet; the field average was 598.8 cubic feet. The mean dif-

TABLE 1.—AVERAGE NUMBER OF TREES PER ACRE BY CROWN CLOSURE AND CROWN DIAMETER CLASSES

Crown closure of dominant stand	Total crown area per acre	Crown diameter classes			
		10 feet	15 feet	20 feet	25 feet
Percent	*Sq. ft.*	*Trees*[1]			
15	6,534	65	29	16	10
25	10,890	109	48	27	17
35	15,246	152	68	38	24
45	19,602	196	87	49	31
55	23,958	240	106	60	38
65	28,314	283	126	71	45
75	32,670	327	145	82	52
85	37,026	370	165	93	59
95	41,382	414	184	103	66

[1]Calculated by dividing total crown areas per acre (column 2) by the squares of the crown diameter classes.

[4]Minor, C. O. Form class volume tables for use in southern pine pulpwood timber estimating. La. Bul. 445, 39 pp. 1950.

[5]Vertical projections of tree crowns are more likely to be rectangular or polygonal than circular. Thus a rectangular crown measuring 8 by 12 feet should be assigned an area of 96 square feet. If the same crown were considered as a circle variant with an average diameter of 10 feet, crown area would be 78.5 square feet. Squaring the average diameter gives 100 square feet, very nearly the true value.

ference of 14.8 cubic feet constituted an error of roughly 2½ percent of the field volume.

The "t" test of paired replicates was used to test the difference in means of the two volume estimates; this difference was not significant at the 5 percent level. It was concluded that the table should yield reliable estimates of mean gross volume per acre in stands similar to those sampled, provided essential photo variables could be determined with reasonable precision.

Practical Application Test

The true value of an aerial volume table is determined by interpreters who must use it. The final test of the composite table was thus one of practical application. Six professional foresters,[6] possessing varying degrees of training and experience, interpreted and classified each of the 50 photo-plots twice. An Abrams 2-4 power lens stereoscope was used in determining the following variables: (1) Average total height of the dominant stand, measured with an Abrams height finder. (2) Average crown diameter of the dominant stand, determined with a dot-type crown diameter scale. (3) Crown closure of the dominant stand, estimated to the nearest 10-percent class. (4) Classification of the dominant stand as one of four broad forest types: mixed pine, pine-hardwood, upland hardwood, and bottomland hardwood.

To assure a maximum of independence between the two sets of photo measurements by each man, several weeks were allowed to elapse between the first interpretation and the second. Interpreters were unfamiliar with the test area, and field volumes were unknown to them.

The six sets of duplicated photo measurements on the 50 test plots resulted in 12 estimates of mean gross volume per acre. Mean differences between estimated and field volumes were subjected to "t" tests. Table 3 summarizes the 12 volume estimates, along with corresponding mean differences between photo and field volumes and standard errors of the mean differences. Eight of the mean volume estimates did not differ significantly from field values, while the differences in the remaining four were highly significant. The eight non-significant estimates were all considered reliable, as none differed from the mean field volume more than 8 percent. Conversely, the remaining four estimates were deemed unacceptable because of excessive variations from actual volumes.

[6]The author is indebted to the following persons who contributed to this study by serving as photo interpreters: Dr. Merle P. Meyer, James Lindquist, and David W. Myhre of the University of Minnesota School of Forestry; Dr. Evert W. Johnson and Forrest E. Goodrick of the Alabama Polytechnic Institute School of Forestry; and Robert W. Neelands of the Southern Forest Expt. Sta.

TABLE 2.—COMPOSITE AERIAL VOLUME TABLE FOR ITAWAMBA COUNTY, MISSIPPI

Average total height	Crown closure percent								
	15	25	35	45	55	65	75	85	95
Feet	*Cubic feet per acre*[1]								
	10-foot average crown diameter								
30	190	310	430	560	690	810	940	1,060	1,180
40	230	380	530	690	840	990	1,140	1,300	1,450
50	260	440	620	800	980	1,150	1,330	1,510	1,680
60	300	500	690	890	1,090	1,290	1,490	1,680	1,880
70	340	570	800	1,030	1,260	1,490	1,720	1,950	2,180
80	380	640	890	1,140	1,400	1,650	1,910	2,160	2,420
	15-foot average crown diameter								
30	210	350	500	640	780	930	1,070	1,220	1,360
40	260	430	610	780	950	1,130	1,300	1,480	1,650
50	310	510	730	830	1,140	1,350	1,550	1,770	1,970
60	360	590	930	1,070	1,300	1,550	1,780	2,030	2,260
70	400	660	940	1,200	1,460	1,740	2,000	2,280	2,540
80	440	740	1,040	1,330	1,620	1,930	2,220	2,530	2,820
90	480	800	1,140	1,450	1,770	2,100	2,420	2,760	3,070
	20-foot average crown diameter								
40	270	450	630	820	1,000	1,190	1,370	1,550	1,720
50	320	540	750	970	1,190	1,410	1,630	1,840	2,040
60	360	610	860	1,110	1,360	1,600	1,850	2,100	2,330
70	410	680	960	1,240	1,520	1,800	2,080	2,360	2,610
80	450	760	1,070	1,380	1,690	2,000	2,310	2,620	2,900
90	500	840	1,190	1,530	1,870	2,220	2,560	2,900	3,220
100	540	920	1,290	1,670	2,040	2,410	2,790	3,160	3,500
	25-foot average crown diameter								
50	320	550	770	1,000	1,220	1,450	1,670	1,900	2,120
60	370	620	880	1,130	1,390	1,650	1,900	2,160	2,410
70	410	700	980	1,270	1,550	1,840	2,130	2,410	2,700
80	460	780	1,100	1,420	1,740	2,060	2,380	2,700	3,020
90	510	860	1,220	1,570	1,930	2,280	2,640	2,990	3,350
100	550	940	1,320	1,710	2,090	2,480	2,860	3,250	3,630

[1]Based on Girard form class 77. Gross volumes are inside bark and include the merchantable stem to a variable top not smaller than 3 inches i. b.

Variations in Photo Measurements

As can be seen in Table 3, interpreters "B" and "C" obtained satisfactory volume estimates on

TABLE 3.—RESULTS OF "t" TESTS FOR 12 PHOTO ESTIMATES OF GROSS VOLUME PER ACRE ON 50 FOREST PLOTS

Estimate	Mean volume per plot[1]	Mean volume difference	Standard error, mean difference
A-1	567.90	— 30.90	±25.30
A-2	574.80	— 24.00	±38.09
B-1	773.20	+174.40**	±42.20
B-2	552.40	— 46.40	±42.30
C-1	737.20	+138.40**	±34.36
C-2	633.00	+ 34.20	±39.47
D-1	623.60	+ 24.80	±66.96
D-2	643.00	+ 44.20	±64.17
E-1	414.80	—184.00**	±40.62
E-2	481.20	—117.60**	±36.22
F-1	571.08	— 27.72	±43.93
F-2	552.20	— 46.60	±28.64

**Difference significant at the 1 percent level.
[1]True mean volume: 598.80 cubic feet.

TABLE 4.—MEAN DIFFERENCES AND STANDARD ERRORS OF MEAN DIFFERENCES FOR 12 PHOTO ESTIMATES OF TOTAL HEIGHT, CROWN DIAMETER, AND CROWN CLOSURE

Estimate	Total height		Crown diameter		Crown closure	
	Mean diff.	Std. error	Mean diff.	Std. error	Mean diff.	Std. error
	Feet		*Feet*		*Percent*	
A-1	−2.70	±1.37	+1.58**	±0.43	− 0.60	±1.29
A-2	−2.10	±1.12	+3.08	±0.52	− 0.50	±1.62
B-1[1]	−5.30**	±1.56	−1.12*	±0.43	+13.80**	±2.21
B-2	−2.70	±1.43	−0.42	±0.58	− 1.00	±2.08
C-1[1]	−1.90	±1.66	−1.12	±0.59	+ 9.40**	±1.72
C-2	−4.70**	±1.48	−3.12**	±0.49	+ 5.60	±2.88
D-1	+7.50**	±1.21	−0.22	±0.47	+ 2.80	±2.97
D-2	+8.90**	±1.16	+0.38	±0.45	+ 0.40	±2.87
E-1[1]	+4.70**	±1.28	+1.78**	±0.58	−11.60**	±1.57
E-2[1]	+7.90**	±1.25	+1.38**	±0.44	− 9.60**	±1.46
F-1	−3.50**	±1.26	+1.88**	±0.54	− 0.80	±2.04
F-2	−3.50**	±1.02	+0.88	±0.44	− 1.80	±1.42

[1]Estimates with significant differences in mean volume.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

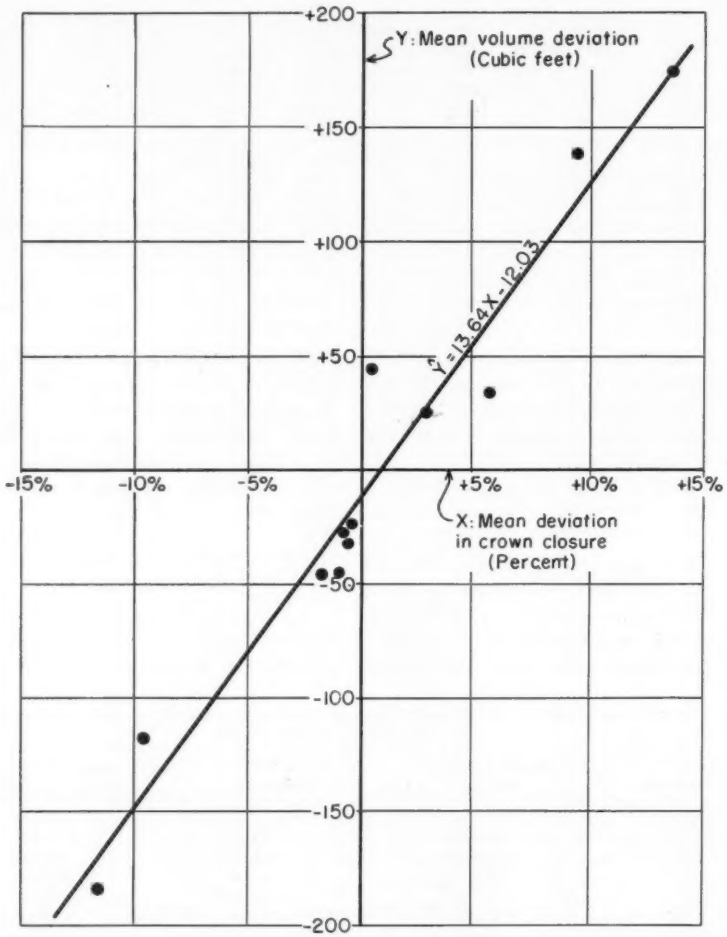

FIG. 3.—Regression of mean volume deviations on mean crown closure deviations.

Pine poles
Pine-hardwood poles
Upland hardwood poles
Upland hardwood poles
Upland hardwood sawtimber
Bottomland hardwood sawtimber

the second cycle of measurement, following highly significant overestimates on the first phase. Both estimates by interpreter "E" were significantly low. In an effort to isolate specific causes for these large volume differences, mean deviations between photo and field estimates of total height, crown diameter, and crown closure percent were also subjected to "t" tests. Results are given in Table 4.

Although significant differences were occasionally revealed in photo estimates of total height and crown diameter, the most striking trend was exhibited by deviations in crown closure percent. As Table 4 shows, the two highly significant overestimates of mean volume (B-1, C-1) were accompanied by highly significant overestimates of crown closure. Likewise, the two significant underestimates of mean volume (E-1, E-2) were associated with highly significant underestimates of crown closure.

To determine more precisely the relationships between photo variables and the dependent estimates of average volume per acre, mean volume differences were plotted over mean deviations in height, crown diameter, and crown closure. Linear regressions were fitted to each set of paired differences. As expected, the most striking linear trend was exhibited by the regression of volume differences over crown closure differences. This relationship, significant at the 1 percent level, is graphed in Figure 3. It was concluded that significant underestimates of mean crown closure percent will result in negative volume differences, while overestimates of mean crown closure are likely to produce positive volume differences.

Mean deviations in total height and crown diameter were not significantly related to mean volume differences, but crown diameter deviations were related to crown closure deviations, which in turn affected volume differences.

Forest Type Identification

During the first phase of photo interpretation, each of the 50 test plots was placed in one of four

broad type categories: mixed pine, pine-hardwood, upland hardwood, and bottomland hardwood. From the identification summary in Table 5, it can be seen that mixed pine stands were correctly identified 74 percent of the time; pine-hardwood, 49 percent; upland hardwood, 83 percent; and bottomland hardwood, 33 percent. Pine-hardwood stands were classed as mixed pine in 24 percent of the identifications and as upland hardwoods in an additional 24 percent. This suggests that interpreters had difficulty with "borderline plots," i.e., stands composed of approximately 50 percent pines and 50 percent hardwoods.

From this test, it appeared that upland hardwoods could be most consistently recognized on 1:20,000 panchromatic photography. By contrast, the bottomland hardwood type showed the lowest percentage of correct identifications. The fact that 52 percent of the interpretations of these plots resulted in a classification of mixed pine or pine-hardwood was attributed to dark photographic tones, caused primarily by moist site conditions. Such tonal patterns apparently influenced photo interpreters more than the topographic positions of the stands.

TABLE 5.—SUMMARY OF FOREST TYPE IDENTIFICATIONS MADE BY SIX INTERPRETERS ON 50 PHOTO-PLOTS IN NORTHEAST MISSISSIPPI

Forest type	No.	Summary of identifications: Mixed pine	Pine-hardwood	Upland hardwood	Bottomland hardwood
		Percent			
Mixed pine	7	74*	19	7	–
Pine-hardwood	13	24	49*	24	3
Upland hardwood	22	6	11	83*	–
Bottomland hardwood	8	15	37	15	33*

*Correct identications.

Although some of the interpreters lacked intimate knowledge of southern forest type associations, the test does indicate the futility of having different aerial volume tables for forest types that cannot be consistently recognized. Unless type stratifications are 85 to 90 percent correct, the construction and use of separate aerial volume tables is questionable. Results illustrated here strengthen the argument for composite tables that can be applied to species mixtures.

Conclusions

This study in northeast Mississippi indicated that:

1. Mixtures of loblolly-shortleaf pines and hardwoods cannot be effectively separated on 1:20,000 panchromatic photography for evaluating stand volume per acre. Separate aerial volume tables for such species associations are therefore of doubtful utility.

2. It is possible to construct aerial stand volume tables applicable to pine-hardwood mixtures. They may be compiled from individual tree measurements, provided that acceptable relationships can be established between stem diameters and crown diameters.

3. Composite aerial volume tables should yield estimates of mean cubic volume per acre within 10 percent of actual field volume when photo measurements of total height, crown diameter, and crown closure can be reliably determined. Crown closure is the most difficult of the three variables to evaluate, and excessive errors will materially affect the final volume estimate.

4. Field data for constructing aerial volume tables could be collected on Forest Survey plots at minimal additional cost. Thus tables of regional application appear economically feasible.

Report on Connecticut's Timber Resource

Forests occupy nearly two-thirds of the 3 million acres of land in Connecticut, according to a survey completed by the Forest Service, U. S. Department of Agriculture.

The forest-land area consists of almost 2,000,000 acres. Most of the forest land is stocked with small trees, the survey found.

This survey, reported as the first intensive one ever made for the whole state, was carried out by the Northeastern Forest Experiment Station in cooperation with the State Park and Forest Commission of Connecticut.

About 2 billion board feet of sawtimber are growing on forest land in Connecticut, but only one-sixth of the forest area has stands of 1,500 or more board feet per acre. The sawtimber volume is about equally divided between the oaks and all other species. More than half the board-foot volume was found in trees less than 15 inches d.b.h. Due to hurricanes and other causes, less than 4 percent of the present board-foot volume is made up of white pine.

Sawtimber volume is increasing about four times as fast as it is being cut, but nevertheless the growth rate per acre is low—about 54 board feet per acre per year, the survey revealed.

Ninety percent of the forest land is privately owned—25 percent by farm operators and 65 percent by a diverse group of owners. The 10 percent in public ownership is mainly in state forests, according to the report.

Copies of the report can be obtained from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

Pole Blight—How It May Influence Western White Pine Management in Light of Current Knowledge

Charles D. Leaphart[1]
Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture

ADEQUATE AND TIMELY planning is one prerequisite to good management. Productivity of unit areas will depend upon the accuracy and judgment used in management planning. The pole blight disease of western white pine (*Pinus monticola* Dougl.) illustrates one difficulty in fulfilling such an objective when predicting the future of white pine management. The cause of this disease has not been determined; nevertheless, the forest manager should know what the future may hold and what steps he may be required to take to produce a marketable stand within rotation age. Methods and suggestions presented here show how one might manage white pine on the basis of what is known about the disease to date.

Nineteen years ago the first research was started to determine the cause of pole blight, almost 10 years after it was first discovered. Neither at the time the disease was discovered nor when research into its cause was begun was the disease recognized as one representing a potential roadblock to and another milestone in the management of western white pine. Pole blight is potentially the most serious disease of this species because a considerable acreage in pole stands is already affected and, with the cause and control undetermined, it has a relatively unknown effect on all phases of white pine management.

Such a statement may sound strange to people who have recognized blister rust (*Cronartium ribicola* Fischer) as the number one enemy of western white pine. $1,300,000 is now spent annually in the Inland Empire to control blister rust and provide protection of white pine. This cost will represent approximately $2 per thousand board feet on the estimated future yield of this species from this area.

The primary objective in white pine management is to prolong the highest annual cut from present stands and to provide for an eventual cut of 500 million board feet after 80 years. Pole blight may prevent full attainment of this objective or may necessitate material change in the direction of the white pine program. On some sites pole blight may break the 100- to 120-year rotation age, provided for in current management plans, at any age above 40 years. Not all pole stands are affected by pole blight and some will probably never be affected. This has not been proved, however, and until the cause of pole blight has been definitely determined, most stands of the 40- to 100-year age class should be considered potentially susceptible to the disease. To what extent is money being spent for blister rust control to bring trees through the reproduction stages only to be affected later by another disease? This question is of serious concern to all people involved in western white pine management.

Western white pine forests of the Inland Empire embrace an area of 3,600,000 acres (*9*). To date, 1,134,610 acres are within blister rust control units (*13*). Pole stands 40 to 80 years old occur on 304,420 of these acres, and reproduction stands 0 to 40 years old on 334,840 acres. Pole blight has caused 78,120 acres to be dropped from control units, about 7 percent of the present control area. It occurs on an additional 33,555 acres within 42 control units. Blister rust control and timber management personnel feel that with many unanswered questions on pole blight, certain calculated risks must be taken in selecting white pine management units. Pole blight damage is one factor that lowers the classification of a white pine unit. Where the remaining estimated future white pine yield sufficiently justifies protection costs, the unit is retained in the white pine blister rust control program. The question is posed: How much of the reproduction acreage in the future will become infected with pole blight? Approximately two-thirds of the present reproduction acreage in control units lies north of the most southern known occurrence of pole blight.

White pine management is faced with still another problem in addition to blister rust. Approximately one-fourth of the total white pine acreage under control is in the pole size class (*13*). The present acreage in the age classes that include the pole stands does not adequately provide for a sustained cut at present levels. Losses from any cause, including pole blight, will further aggravate the deficiency in these age classes.

The best available estimates show that nearly one-seventh of the present western white pine pole stand acreage is affected by pole blight. On this acreage slightly more than 50 percent of the white pine, based on basal area, is diseased or dead (*5*). When one realizes that more than 90 percent of the diseased trees are dominant or co-dominant individuals, that is, the crop trees, this figure is even more significant: It means that many of these affected stands will contribute little to the white pine industry.

What, then, might the forest manager do to combat this disease? Current and past research to determine the cause of pole blight has provided a number of leads and possibilities. At this point the more significant leads and their implications on white pine management should be discussed.

Ehrlich and Baker (*2*), Gill *et al.* (*3*), Leaphart (*7*), Leaphart and Copeland (*8*), and McMinn (*11*) have demonstrated an abnor-

[1]Pathologist, Division of Forest Disease Research, Inland Empire Research Center, Spokane, Wash.

mally high deterioration and mortality in the root systems of pole-blighted white pine trees and stands. McMinn concludes that a root pathogen capable of producing the deterioration of the structural system is not the cause of pole blight, but that the decline is systemic in nature accompanied by a reduction in mycorrhizal vigor (*12*). Studies on rootlet mortality and density and certain characteristics of soil underlying diseased stands tend to support this idea (*8*).

The high deterioration in the root systems, particularly the fine absorbing portion of diseased white pine stands or of healthy stands within and adjacent to diseased stands, could be caused by pathological, entomological, physiological, or other agents. This deterioration in the fine root system is the hub around which pole blight revolves and is essentially the initial stage of pole blight. McMinn (*12*) believes that the subnormal root condition may be responsible for the development of the crown and stem symptoms or may simply be the result of a general physiological decline of the tree from some unknown cause.

The following observations suggest an edaphic-physiologic cause of pole blight:

1. No stands affected by pole blight have been found on soils having more than 5.0 inches of available moisture storage capacity in the upper 3 feet of soil, but the disease is commonly encountered on soils having storage capacities ranging from 0.7 to 5.0 inches. The average available moisture storage capacity for 113 diseased plots studied to date is 3.32 inches. Roots are able to grow in only 68 percent of the top 36 inches on these plots. This compares with an average 4.09 inches of storage capacity and 78 percent of the 3 feet available for root activity in 187 healthy plots in diseased areas, and 4.78 inches and 93 percent in 52 healthy plots in healthy areas. These observations show that, with fewer factors like rock and hardpans limiting soil depth, a significantly greater opportunity for uniform root growth and distribution is provided for in the healthy plots, particularly those in healthy areas.

TABLE 1.—THE PERCENTAGE OF RANDOMLY SELECTED WESTERN WHITE PINE SITES THAT MIGHT BECOME DISEASED AS PREDICTED FOR VARIOUS SOIL MOISTURE RECHARGE POTENTIALS AND AVAILABLE MOISTURE STORAGE CAPACITIES

Available moisture storage capacity	Soil moisture recharge potential		
	Good	Moderate	Poor
	Percent stands affected		
0.0	67.10	82.80	98.50
0.4	61.54	77.24	92.94
0.8	55.98	71.68	87.38
1.2	50.42	66.12	81.82
1.6	44.86	60.56	76.26
2.0	39.30	55.00	70.70
2.4	33.74	49.44	65.14
[1] 2.8	28.18	43.88	59.58
3.2	22.62 ± 4.94[2]	38.32	54.02
3.6	17.06 ± 4.92	32.76	48.46
4.0	11.50 ± 4.98	27.20	42.90
4.4	5.94 ± 4.92	21.64 ± 4.57	37.34
[1] 4.8	.38 ± 5.03	16.08 ± 4.70	31.78
5.2	.00	10.52 ± 4.91	26.22
5.6	.00	4.96 ± 5.18	20.66 ± 5.53
6.0	.00	.00	15.10 ± 5.85
6.4	.00	.00	9.54 ± 6.20
6.8	.00	.00	3.98 ± 6.60
7.2	.00	.00	.00

[1]These lines delineate risk classes.
[2]Fiducial limits at 95 percent probability.

Among the white pine pole-size stands affected by pole blight, those having lower storage capacities are significantly more damaged by the disease than those having high capacities. Within diseased stands this soil moisture factor accounts for only 15 percent of the variation in the percentage of white pine basal area damaged. Apparently, other factors such as the time period that a stand is affected, the normal biological processes involved in tree deterioration after stand vigor is reduced and mortality starts, and others, mask or confound the real significance of the soil moisture factor in contributing to stand decline. Previous studies (*8*) showed that white pine rootlet mortality and rootlet density were closely correlated with available moisture storage capacity. Though both rootlet mortality and a reduction in rootlet density have not been proved as a cause of pole blight, these two studies lend more significance to the role that soil moisture plays in pole blight decline than has been apparent heretofore.

Although both uniform root growth and available moisture storage capacity of the soil are quite significant in determining the health of a stand, adequate soil moisture distribution and availability from sources other than precipitation (soil moisture recharge potential[2]) are also important. A recent soil survey of 319 plots in pole-size white pine stands located throughout the white pine type in northeastern Washington, northern Idaho, and western Montana showed that pole blight incidence was correlated with available moisture storage capacity and soil moisture recharge potential, exclusive of direct precipitation (exceeded the 1 percent level of significance). Of all the recorded data that included ground cover density and composition, basal area per acre of all tree species, site index, and soil depth to zone limiting root penetration, only the two soil moisture factors were correlated with disease occurrence. They accounted

[2]Soil moisture recharge potential is considered here to be the movement, distribution, and availability of underground water. The following factors were used to estimate the relative potential for soil moisture recharge, that is, good, moderate, or poor, for a particular site: steepness of slope, site location and position on slope (ridgetop, bottom, bench, midslope, etc.), the surface area and topography above a site contributing to water storage, location with respect to existing water points (living or intermittent springs and streams, seepage areas, etc.), depth to water table, soil depth and characteristics, and parent geological material and structure.

for 70 percent of the variation in the incidence of pole blight. The percentage of 100 randomly selected white pine sites that might become diseased is predicted for various levels of recharge potential and available moisture storage capacities in Table 1.

2. Climatic records show that white pine stands went through a period of low precipitation and high temperature from 1917 to 1940. Since that period, certain years (some successive) have had below normal precipitation. Using records of certain stations both near and outside pole blight areas, Wellington (*14*) found a highly significant relationship between the occurrence of pole blight and both summer precipitation and temperature when combined in a multiple analysis. Dendrochronological records (*10*) suggest that the period climaxing in 1929-1930 was the driest that existing stands of any age class in the white pine type ever underwent. In eastern Oregon, only several hundred miles removed from this type, Keene (*6*) went back nearly 400 years in his dendrochronological records without finding as dry a period as this same one which started in 1917 and was followed by gradual encroachment of desert conditions into what were once thriving pine (in this case *Pinus ponderosa* Laws.) stands during the next two decades. Studies on the Grinnell Glacier in Glacier National Park also point out the seriousness of inadequate precipitation and of high temperatures for the same period (*1*). The author concluded that the dry cycle starting in 1917 and lasting until 1946 was somewhat uniform throughout the State of Montana.

McMinn believes that such an adverse climatic condition might affect white pine more severely than other species or recovery from ill effects may be less rapid (*12*). Of the species commonly found in association with western white pine, only western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), grand fir (*Abies grandis* [Dougl.] Lindl.), and western redcedar (*Thuja plicata* Donn.) also have fairly narrow climatic and geographic ranges. Western larch (*Larix occidentalis* Nutt.), Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), and lodgepole pine (*Pinus contorta* Dougl.) are commonly found on drier sites than one normally expects to find white pine. Grand fir, to a lesser extent, also occurs on drier sites than white pine. On the fringe of its type, white pine is limited to the creek bottoms, sites within and just below spruce basins, or other moist situations. Western hemlock, western redcedar, grand fir, and Engelmann spruce (*Picea engelmannii* Parry) are compensated in other ways to be explained later when moisture stresses might be detrimental to tree health.

3. Primarily age, site quality, and basal area determine rootlet density in healthy white pine stands (*8*). Rootlet density begins to fall below a standard of 100 percent at about the age of 100 years. Normal pole stands have a density equivalent to 190 percent, while in diseased stands it is about 65 percent. Healthy stands adjacent to diseased stands have nearly the same density as diseased stands. Rootlet mortality at any given sampling in normal stands is about 3.5 percent, in healthy stands in diseased areas about 6.5 percent, and in diseased stands around 9 percent. In studying individual trees, Ehrlich and Baker (*2*) and McMinn (*9*) found that rootlet mortality runs as high as 100 percent in severely diseased trees. Just where the threshold of tree vigor lies in determining whether the remaining rootlets die because of internal physiological causes instead of environmental or pathogenic factors is not known. However, an intense reduction in tree vigor and internal physiological stresses probably causes much of the rootlet mortality in severely diseased trees.

4. Although fundamental studies are now in progress to determine the effect of moisture deficiencies and stress on rootlet mortality, some empirical information has been accumulated. Rootlet mortality studies made from 1952 through 1955 showed a considerable variation in mortality rates from one year to the next (*8*). Rootlet mortality in western white pine for all areas sampled in 1952 and 1953 ranged from 10 to 26 percent but only from 2 to 15 percent for 1954 and 1955. Using annual weather records of stations apparently similar in climatic variation to those of the root study areas, a regression analysis showed that rootlet mortality in all areas studied during the four years increased significantly as total summer precipitation, June 1 through September 30, decreased. Such observations suggest that moisture stresses directly influence rootlet mortality: the studies now under way should throw considerable light on this possibility.

5. Root studies made in a stand affected by pole blight suggest that all other tree species are better able to compete for available moisture than is white pine, considering rootlet density and length as the only measures of competition (*7*). Both rootlet density and length of western hemlock, western redcedar, grand fir, and Engelmann spruce are two to four times greater than western white pine. Those species like western white pine are restricted by climatic or other conditions where moisture appears limiting to their growth and occurrence. Of the four species, only cedar, grand fir, and hemlock occur in any great quantity on pole blight areas, but they are usually as subdominants to white pine. Although they have a higher exposed needle surface on an equivalent basal area basis, their evapotranspiration stress should be lower since they normally occupy a lower crown position than pine, but we need definite information on this point for all crown classes.

6. Experimental thinnings and salvage operations indicate no cutting method currently in use effectively retards or halts progress of the disease (*4*). If moisture deficiencies alone were the cause of

pole blight, cuttings or thinnings should improve the moisture regime for white pine and reduce or prevent the damage caused by pole blight. On the other hand, residual stumps provide a source for the buildup of inoculum of fungi like *Armillaria mellea*. In pole blight or pole blight susceptible stands, observations suggest a reduction in general stand vigor that sets up an ideal situation for a buildup of Armillaria, for example. This fungus could prolong and intensify general stand deterioration, the symptoms of which resemble or combine with normal pole blight symptoms. Similarily, once mortality from pole blight starts in a stand, almost the same opportunity for pathological buildups occurs as for one resulting from a thinning operation. Perhaps this explains in part why stands continue to suffer from pole blight during the present climatic cycle that seems relatively favorable for white pine growth. In addition, any thinning of a stand produced artificially or by excessive mortality, might increase evapotranspiration in the residual dominant and codominant classes of trees. If this does occur, an additional stress is placed on an already subnormal root system to supply the tree's increased demand for moisture. Hence a continuation or even an intensification of pole blight occurs within a stand once pole blight mortality starts or a thinning is made at a critical time in the life of a stand.

7. Studies of other species suggest that the period of highest physiological activity starts fairly early in a tree's life, between 20 and 40 years of age. Maximum competition and stand closure occurs at approximately 30 years in western white pine stands. Volume production of wood is just starting into its peak at this age also, reaching a maximum near 60 years for the average site. Pole blight affects the stand during this period, predominately the 60-year age class, and primarily the dominant class at that. If one adds a period of severe moisture stress and an inadequately absorbing root system at this critical stage, the relationship acquires even greater significance.

A summary of the investigations on other possible causes of pole blight reveals considerable voids in our knowledge of their relationships to the disease. One generally assumes that any virus, fungus, or insect contributing to the pole blight decline is able to operate effectively only under the predisposing soil factors previously highlighted. Nevertheless, the following observations merit consideration in formulating recommendations that might be made for control of this disease.

1. No fungus has been isolated and identified as the cause of rootlet deterioration. *Armillaria mellea* is recognized at present as the most predominant root pathogen in white pine pole stands. *Leptographium* spp. have frequently been isolated from diseased trees and have killed white pine roots under artificial inoculation conditions. Root and stem inoculations with this fungus have not reproduced pole blight symptoms. Though some other organism were isolated even more frequently and shown to have an ability to destroy white pine rootlets, one should hesitate to assign sole responsibility to it as the causal organism. If a fungus (or fungi) is responsible for root and rootlet deterioration, it appears to be neither virulently pathogenic nor introduced, but instead, to be an indigenous pathogen of opportunity.

2. No virus has been detected in the various tests to date. Although no virus has yet been found affecting a conifer, one might be present in western white pine and responsible for pole blight. More intensive research is needed to prove or disprove the presence and importance of a virus.

3. No primary insects that could cause rootlet deterioration have been found in stands affected by pole blight. Although parasitic nematodes have been observed in white pine pole stands, no proof of their parasitic potential on white pine or of their relationship to pole blight has been presented.

4. With the present knowledge on the distribution of pole blight and its relationship to certain soil characteristics, should one stop future research if some organism or physiological requirement is discovered that will reproduce all or part of the pole blight symptoms in healthy trees? Apparently, from this point on, research must run the entire gamut of possible causes to determine whether this pole blight problem is one specific disease, or a complex of different disorders.

While different interpretations could be put on these factors, they suggest that the cause of pole blight is basically physiological. The recommendations for future white pine management that might be made using the above knowledge on edaphic-physiologic relationships are essentially as follows and are based upon our ability to (1) classify all sites by the two soil characteristics, effective soil depth, and available moisture storage capacities; (2) predict the probability of recurring dry cycles similar to the one occurring in the past 50 years; and (3) develop accurate and standard means of judging amount, depth, and duration of underground water flow for any site.

1. Blister rust control units, both present and potential, for white pine management would be classified on the basis of three risk categories with the following descriptive limits:

High risk. — Sites within the range of available moisture storage capacities and recharge potentials occurring above the dotted line in Table 1. If white pine is to be grown, it would be on short rotations of 40 to 60 years. Longer rotations will be determined by long range climatic cycles.

Moderate risk.—Sites within the range of available moisture storage capacities and recharge potentials occurring between the solid and the dotted lines in Table 1. Pole blight will occur on some of these sites, especially if the white pine

stands reach 40 years of age at the start of the decline in a low precipitation, long range cycle. Rotations could be planned for 100 to 120 years but may be shortened for certain sites depending upon climatic factors and the limitations in underground water flow.

No risk.—Sites within the range of available moisture storage capacities and recharge potentials occurring below the solid line in Table 1. Rotations for growing white pine could be planned for 120 years and longer.

2. High and moderate risk categories will usually occur north of the line running generally east and west through Laird Park on the St. Joe National Forest. Few areas north of this line will fall into the no risk category.

3. Sites receiving less than 30 inches of annual and 5 inches of summer (June 1 through September 30) precipitation over consecutive periods of two or more years in the past would normally fall in the high and moderate risk categories.

4. Effective soil depth noticeably influences root penetration. Pole blight occurs on a few soils in which all of the top 36 inches of soil mantle are available to root growth but in general such soils are subject to little or no underground moisture recharge. Where soil depths are limited by hardpan layers or by rock, such sites would seldom fall in the no risk category. If the effective soil depth extends one or more feet past the 3-foot limit, the site would usually be classed as no risk.

The foregoing risk classification is one possible means of approaching control of pole blight if future research does not reveal a more direct cause. Should the cause be proved to be directly associated with a fungus, a virus, an insect, some specific physiological requirement, or any combination thereof, recommendations for management could be along any of the following lines.

1. A genetics program might be undertaken to develop planting stock resistant to the causal agent. Several considerations must be faced, however, if a genetics program is to be launched: (1) That a development program for producing stock resistant to blister rust is already under way. If both the rust resistance factor (or factors) and a pole blight resistance factor are to be developed in one plant, the chances of success would be decreased and the feasibility and cost of undertaking such a program might be impracticable. If physiological causes are involved, the problem may simply be one of developing an elite tree resistant to blister rust and possessing, for example, an ability to produce a fibrous root system under all site conditions. (2) That if resistance is to be obtained for a single pole blight cause but only at the expense of the blister rust resistant factor, it might be desirable to initiate a project toward developing pole blight resistant stock in addition to the project for blister rust. Stock from the latter would be used to plant in areas where no pole blight is likely to occur. Stock with the pole blight resistant factor would be planted in susceptible areas where control of blister rust can be obtained by our present practices.

2. If the agent or agents causing pole blight are associated with rootlet mortality, probably no recommendations for direct control would be economically feasible under natural stand conditions, particularly for fungus or "nematological" causes. However, a vector for a virus might be subject to normal entomological control.

3. Recognizing that some agent may be the direct cause, it may be impossible to develop resistance to it or to apply direct control measures. Only one alternative would be left — to manage white pine on a risk classification built around soil factors influencing soil moisture. This drastic measure would restrict volume production of this species in the next rotation much below the present demand.

Perhaps not enough facts on pole blight are available to guide our thinking on western white pine management. However, on more than 350 plots scattered throughout the white pine type in the Inland Empire, pole blight has not been encountered where soils have an available moisture storage capacity greater than 5.0 inches nor where they are characteristically deep, exclusive of the pure sands. Also, the disease has not spread into the southern part of the white pine type, nor, with few exceptions, into stands that were healthy four years ago. A framework is available on which to advise forest managers, but it involves a certain risk that cannot be fully calculated at present.

Future research on pole blight will be more specialized and therefore more costly and time-consuming. Projects, such as virus studies, physiological studies, and isolation studies to be followed with Koch's postulates for proving pathogenicity, will take years to complete. Although the cause of pole blight may still remain a mystery, valuable information will assuredly be forthcoming from such studies. However, without more knowledge which research must provide, forest managers would be forced to resort to risk management. A period of 10 to 15 years of research and observation on trends of the disease may be necessary to show if proposals outlined here are in fact real.

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Effects of Seedbed Conditions on Yellow-Poplar Regeneration

Stephen G. Boyce
and Robert E. Parry[1]

MANY OBSERVERS have noted that yellow-poplar (*Liriodendron tulipifera* L.) seedlings appear to be most abundant on open, bare areas. McCarthy (*8*) found seedlings of yellow-poplar to be more numerous on burned than on unburned areas. Sims (*9*) found them more numerous after clearcutting forest stands than after partial cutting. Carvell and Korstian (*1*) found more seedlings on areas with little or no leaf litter than on areas with thick leaf litter and more numerous in openings than under forest stands. Engle and Williams (*2*) found more yellow-poplar seedlings in skid trails, loading areas, and around stumps than on undisturbed forest litter. To the authors' knowledge, results of experiments designed to test these observations have not been published. So a study was begun in southeastern Ohio to find out just what effect various kinds of seedbed conditions and crown cover have on germination of yellow-poplar seeds and survival of the seedlings.

[1]This study was made while Boyce was assistant professor of botany at Ohio University and Parry was a graduate student. Boyce is now forester at Carbondale Research Center, Central States Forest Expt. Sta.

Methods

Experimental design.—Two experimental blocks were located in a small valley near Athens, Ohio. One block was located in the lower portion of the valley in a field that had a cover of broomsedge (*Andropogon virginicus* L.), goldenrod (*Solidago canadensis* L.), and asters (*Aster ericoides* L., *A. novae-angliae* L.). The other block was located in the same valley in a woods that had a tree cover of yellow-poplar, sycamore (*Platanus occidentalis* L.), white ash (*Fraxinus americana* L.), elm (*Ulmus rubra* Muehl., *U. americana* L.), and buckeye (*Aesculus octandra* Marsh.).

Each experimental block consisted of 16 plots (each 3 feet square) arranged in the form of a latin square (*10*). Each block consisted of four rows and four columns, and each row and each column was separated by a 1-foot isolation strip. Thus each block (latin square) represented four seedbed conditions with four replications. The rows were oriented perpendicular to the direction of slope.

Treatment A consisted of leaving the plot surface relatively undisturbed. However, the loose organic matter of both the woods and field was carefully searched and any naturally occurring yellow-poplar samaras were removed. The seedbed consisted of undecomposed organic matter.

Treatment B consisted of removing all undecomposed and partly decomposed organic matter, the L and F layers (*7*), leaving a seedbed of well-decomposed, amorphous organic matter, the H layer. This layer was carefully searched and any naturally occurring yellow-poplar samaras were removed.

Treatment C consisted of removing all surface organic material and about 1 inch of the A horizon of the soil, leaving a seedbed of exposed A horizon.

Treatment D consisted of removing all surface organic material, the soil A horizon and about 1 inch of the soil B horizon, leaving a seedbed of exposed B horizon.

The plots were prepared in November 1955 and 200 yellow-poplar samaras were scattered on the surface of each plot. On the Treatment A area some of the samaras sifted into the loose organic matter. On the other areas the samaras remained on the surface of the seedbeds. The plots were then covered with 18-mesh metallic screens hav-

TABLE 1.—NUMBER OF YELLOW-POPLAR SEEDS GERMINATING AND NUMBER OF SEEDLINGS SURVIVING

Seedbed	Field		Woods	
	Germination	Survival	Germination	Survival
Undecomposed organic matter	23	20	23	1
Decomposed organic matter	77	44	18	6
Soil A horizon	134	67	48	7
Soil B horizon	82	21	80	1
Total	316	152	169	15

ing a turned edge 10 inches wide. The turned edges were buried 6 inches deep, leaving the screens 4 inches above the plots.

Yellow-poplar seed.—All samaras used in this study were collected from a single tree about 4 miles from where the study was conducted. Examination of a sample of the samaras showed 14 percent contained at least one seed filled with endosperm and presumably viable embryos. The samaras actually used were carefully selected from the collected samaras. All small samaras and those obviously lacking seed were discarded. Of 200 samaras randomly selected from this group, 61 contained one seed filled with endosperm and 18 contained two seeds filled with endosperm. Thus, there were an estimated 48.5 viable seeds per 100 selected samaras.

Results

Germination.—On the field blocks the largest numbers of seed germinated on the surface of the A horizon, the next largest numbers on the decomposed organic matter and on the B horizon. The lowest germination occurred on the undecomposed organic matter (Table 1). These differences were significant at the 5-percent level of probability. A test of significance for individual degrees of freedom (*3*) showed higher rates of germination on the bare soil than on the organic matter.

On the woods block, about half as many seed germinated as on the field block (Table 1). Even though the highest germinations occurred on the soil A and B horizons, there were no significant differences in germination within the treatments, rows, or columns. However, the large mean square for treatments suggests that differences in seedbed conditions did affect rates of germination. A test of significance for individual degrees of freedom again showed higher rates of germination on the bare soil than on the organic matter.

On all blocks germination began the third week in May 1956. Eighty percent of the germination occurred between May 23 and June 10. No seed germinated after July 1.

Recovery of samaras.—On November 5, 576 samaras were recovered from the field block. The number of samaras from each plot varied from 28 to 45. Since there were an estimated 48.5 viable seeds per 100 selected samaras, it was obvious that a small percentage (1 to 48) of the estimated viable seed actually germinated. The wings of most samaras had completely decayed and the other partially decayed wings fell apart during handling. The enlarged portions of the samaras containing the seeds were soft but had not decayed as rapidly as the wings. The seedcoats were intact, hard, and exhibited no external evidence of decay.

Of all the recovered samaras 16.7 percent contained one seed filled with apparently living endosperm, 1.7 percent contained two seeds filled with apparently living endosperm. 9.0 percent contained seedcoats with dried or discolored endosperm, 1.2 percent contained seedcoats from which animals probably had removed the endosperm, and 71.4 percent contained empty seedcoats or no seedcoats.

Personal observations and those of Wean and Guard (*11*) show that the presence of an oily, chocolate-brown endosperm indicates the presence of an apparently viable embryo. If this is true, then an estimated 20.1 seed per 100 samaras remained on the block for one year without germinating and apparently without deteriorating. McCarthy (*8*) describes two instances in which yellow-poplar seed apparently germinated during the second growing season after its fall and suggests that yellow-poplar seed that does not reach mineral soil may remain dormant for a year or possibly longer. It is not known whether any of the recovered seed from the field block of this study would have germinated during the second growing season. The evidence suggests that additional studies are needed to properly evaluate the length of viability of yellow-poplar seed under natural conditions.

Mortality.—Most seedling mortality in both the field and woods occurred from the middle of July to the last of August. No mortality was noted between September 10 and November 5, when the last observations were made.

On the field block, 164 of the 316 seedlings were dead by November 5; a mortality of 52 percent. However, among the seedbeds the rates of mortality were significantly different. The bare soils of the A and B horizons in the field, which had the highest germination rates, also had the highest mortality rates. Nevertheless, on November 5 there were 67 and 44 surviving seedlings on the A horizon and on the decomposed organic matter, respectively, compared with 20 and 21 seedlings on the untreated plots and on the B horizon, respectively. Thus, the highest rates of seedling establishment, after one season, occurred on the soil A horizon and on the thin layer of decomposed organic matter (Table 1).

In the woods, 154 of the 169 seedlings were dead by November 5: a mortality of 91 percent. The high mortality on this block was possibly due to poorer light and soil moisture conditions.

Discussion

The results of this study support previous observations (*1, 2, 8, 9*) which indicate the natural establishment of seedlings of yellow-poplar to be more numerous on seedbeds with little or no organic matter than on seedbeds with thick

organic matter, and to be more numerous in openings than under forest stands.

The increased rates of germination on bare mineral soil and in open areas may be associated with prechilling of the seed. The presence of a layer of organic material reduces the maximum temperature, raises the minimum temperature, and reduces the range of temperature in the seed stratum (*4, 6, 12*). Greenhouse plantings of yellow-poplar seed which has been stratified for 45 days at constant temperatures of 0, 5, or 10 degrees C. and daily and weekly alternating temperatures of 0 to 10, 5 to 10, and 5 to 15 degrees C. gave high germination percentages. However, alternating temperatures of 10 to 2 0and —5 to 5 degrees C. greatly reduced subsequent germination (*5*). Thus, the increased rates of germination on the decomposed organic matter and on the bare soil could have been due to pregermination effects of temperatures associated with the seedbeds.

Since measurements of environmental factors within plots were not taken, it was not possible to relate mortality to specific differences among seedbeds.

Summary

The rates of seed germination and seedling mortality of yellow-poplar associated with four different seedbeds ranging from undecomposed organic matter to bare surface of the soil B horizon were observed on a wooded area and in a field.

On the basis of evidence presented in this paper, the chances of obtaining natural regeneration of yellow-poplar are better in open areas than under dense canopies, and are better on the surface of the soil A horizon or on well-decomposed organic matter (the H layer) than on undecomposed organic matter or on the surface of the soil B horizon. However, additional studies of the effects of seedbed conditions under different types and densities of canopies are needed. Since large numbers of apparently viable seed occurred on the field plot after one year, the evaluation of the effects of seedbed conditions should be based on several years of observations.

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Economics of Site Preparation and Land Regeneration in the South: Example of an Industry Concept

George Anderson

Brunswick Pulp and Paper Company, Brunswick, Georgia

As the price of land, stumpage, and transportation continues to increase, the pulp industry is becoming sharply concerned with the rising cost of wood fiber as a percentage of wood cost. Companies that have acquired forest lands to "ensure a continued wood supply" are now searching for ways of ensuring a very necessary profit from such investments. The time is appropriate for demonstrating to company policy makers the potentials of intensive forest management. Forestry must be related to cost control and company earnings and not treated as an isolated operation or as a necessary inconvenience.

Before intensive forest management will be accepted, it must be established that it is profitable. Foresters in the southern pulp industry are now placing into practice management techniques heretofore considered economically unsound. Brunswick Pulp and Paper Company has adopted an all-out program of management, wherein every acre possible will be handled for optimum production of the best tree species. It can be aptly termed "plantation management."

A soil-site survey of all Brunswick's lands (by Dr. T. S. Coile) has provided the basis for a direct approach to intensive forest operations and planning. We can now prescribe management techniques for each forest site as soil, drainage, and topography dictates.

Within this framework site preparation means brush or undergrowth suppression and land regeneration means tree planting. For effectiveness both must be correlated with site requirements. The type of undergrowth suppression, amount of drainage, species composition, initial tree spacing, thinning schedules—all will determine the degree of success in attaining the growth and yield potential of any given site.

E. L. Demmon states "Few forests respond as quickly to good management as do those in the South. The nature of this response varies widely depending on the kind of treatment given and the conditions under which they are applied." It is almost impossible to visualize the multitude of forest conditions that exist in the Southeast, conditions which may vary greatly on any single forest ownership.

Development of Intensive Management

Between 1940 and 1945 Brunswick carried on a limited tree planting program. Trees were planted only on abandoned fields of newly acquired lands. We began an orderly system of timber harvesting. Artificial regeneration was used only where nature failed completely but rapid industrial expansion following World War II made it unprofitable to carry vast acreages of poorly stocked pine stands.

Planting cutover lands presented a host of problems and early results were not too promising. The first plantings made amidst competing vegetation and logging debris did not fare well. Burning of the undergrowth was tried. This was followed by scalping the turf ahead of the planting machine with the two disc fire line construction

[1]Adapted from a paper presented to the Southeastern Section of the SAF, January 1958, at Panama City, Fla.

Fig. 1.—*Left*: Typical upland hardwood on high hammock site which is being cleared with heavy equipment. *Right*: The same site being harrowed.

plow. Results were better. Initial survival and growth increased.

Scalping soon led to a more complete job of undergrowth suppression and it became standard practice to prepare planting beds by first stripping the area with the two disc plow set so as to throw the soil out. This operation was followed by the Athens harrow set to pull the soil back to form a planting bed. Initial survival now became comparable to that of old field plantations. Early growth was also significantly better.

As the years passed we realized that on the drier sites competition for soil moisture from wire grass and palmetto retarded development of pine seedlings. On wet sites and heavy soils, brush encroachment from the narrow unplowed strips between beds also became a problem.

The development of the seven-foot, Rome, off-set harrow made more complete undergrowth suppression on cutover pine sites possible. This harrow is now used on the less dense ground cover with a D-4 tractor. On more heavily palmetto and brush infested areas a D-6 tractor is used with a nine-foot Rome harrow. The site is first burned and then harrowed completely one time. After lying fallow 2 to 3 months many sites are given a second treatment. This may consist of a second complete harrowing or stripping into beds. Excessive soil moisture may dictate the need for planting beds.

Another, but more limited, phase of Brunswick's undergrowth suppression program consists of removing dense brush and off-site hardwood growth with heavy equipment. This is used strictly for converting upland hardwood and pine-hardwood sites to pure pine. Since these operations are most expensive, activities are confined to sites of an index of 85 or better for pine. Present methods consist of using a D-8 equipped with a Rome K-G blade which slices off all brush and cull trees at ground level. Two D-7's with rock-rakes windrow the brush, which is then burned. The D-7's also with 11 foot Rome harrows then disk the area one time. Large live oaks and cull trees are left to be poisoned.

Some sites with only light brush cover require only two or three diskings with a D-6 or D-7 tractor which, of course, greatly reduces cost. For economy the techniques employed must vary with the site and ground cover.

Seedlings are set out during the first planting season following the brush suppression work. Selection of species to be planted as well as tree spacing is guided by site requirements and site index. A planting prescription is made for each site to be regenerated.

The basic reasoning that has led us to the adoption of a plantation scheme of forest management is as follows:

1. It is no more practical to allow the forest machine to run part time than it is for a paper machine to run at a fraction of full capacity.

2. Potential forest production will be realized only through the proper utilization of the two elements of value in timber management—*time* and *space*. Nature has had infinite time to produce stands that are usually far below the land's capability to produce. Time and space are both worth money and land must be so managed that its maximum production is obtained within a reasonable length of time. A wood using industry has little need of owning forest land unless it intends to manage the land for maximum production. Hence, prompt land regeneration and proper growing space utilization are of primary importance.

3. Shorter rotations will permit more rapid liquidation of present over-mature and under-stocked stands.

4. There is an urgent need of providing for future, concentrated, wood supplies that are adaptable to highly mechanized logging operations, permitting lower wood costs.

5. The reclamation of nonproductive portions of present forest holdings is paramount to sound business management, for further acquisition of expensive, poorly stocked lands to build a timber reserve is uneconomical. When such lands must be purchased to build a forest management unit, owners must of necessity resort to intensive practices to put them into full production as quickly as possible.

6. The development of genetically superior seed sources dictates a plantation management program for at least the first rotation.

It is necessary to test the basic philosophy of plantation management with certain financial analyses.

Appraising Management Alternatives

Innumerable studies can be made of the cost and return from forest management investments. There is no easy way to compare alternatives. One must look beyond the cost and effects of certain treatments upon the specific acre. A working knowledge of accounting principles and company financial policies, plus sound forecasting and lengthy calculations are necessary to fully appraise one system of management versus another. Yet such analyses must be made before any plan will be accepted.

The goal of such analyses should be to prove, first, which scheme of management will furnish the lowest stumpage cost per cord of wood consumed and, second, which will result in the most favorable cash flow. This must be determined for each year in the period of time that it will take to attain a regulated forest.

Annual stumpage costs.—To determine the annual stumpage cost per cord of wood consumed requires the following steps:

1. The allocation of gross annual management costs into that portion to be expensed and that to be capitalized.

2. The calculation of annual depletion rates for each year in the period. The average stumpage cost per cord of wood actually cut then becomes the annual management expense plus the annual depletion divided by the volume cut.

3. To realistically compare each plan, weight must be given to the

amount of wood it is necessary to purchase on the open market. Credit must also be taken for sale of logs and other products.

The annual stumpage cost per cord of total wood consumed then becomes:

$$S = \frac{E + D + WP - WS}{C}$$

Where:

S = Stumpage cost per cord consumed
E = Management expense
D = Depletion rate
WP = Market wood purchased
WS = Net return after depletion for wood sold
C = Total cords consumed

Determining cash flow.—Investors must know what each level of management means in actual cash flow. Before this can be determined future requirements of the Internal Revenue Service must be anticipated and considered in relation to one's own position. Depletion rates are again arrived at by proper consideration of annual growth and removals. To arrive at future cash flow it then becomes necessary to:

1. Determine total annual cash outlay after corporation taxes. This includes all capitalized management costs, one-half expensed management costs and one-half the cost of all market wood purchased.

2. Calculate total cash returned annually after capital gains tax from wood cut for consumption or sale. This includes total depletion plus ¾ of total net return after depletion for all wood cut.

The following formula can then be used to determine future cash flow. (This must be calculated for each year in the period under consideration.)

$$CF = (\tfrac{1}{2}E + Cp + \tfrac{1}{2}WP) - (D + \tfrac{3}{4}WC)$$

Where:

CF = Annual cash flow
E = Expensed management costs
Cp = Capitalized management costs
WP = Value of market wood purchased
D = Depletion
WC = Net return after depletion for wood cut for consumption or sale

Figures are projected after taxes, and depletion rates are arrived at by proper consideration of annual growth as well as annual removals.

Variables.—If all intangibles could be properly evaluated, the ultimate study, that of determining which plan will result in the cheapest *delivered* cost per cord of wood consumed, could be made. A delivered price expressed in rough cords by outside measure is not a yardstick of cost in terms of solid content. Delivered price is incomplete if it disregards the relation between regularity of wood arrivals at the mill, cost of storage and rehandling, pulp quality and yield of fiber, and by-products as affected by losses in storage.

Conclusion

Plantation management is the key to greater mill profits. Maximum utilization of company timber and continuous advance planning of market purchases will stabilize wood deliveries. Ten years of timber planning at Brunswick has stabilized and thereby encouraged production of pulpwood as a regular occupation by competent loggers and woods labor. As a result only an 8 to 12 day inventory is maintained at the mill with no storage in the field.

Largely by improving wood preparation and using fresh wood, the consumption of wood since 1946 has been reduced over 0.2 cord per ton of bleached sulphate pulp (combined average for pine and hardwood). Had not this reduction been made Brunswick would have used 40,000 more cords of wood in 1957. No part of this saving appears in wood cost, nor does wood cost reflect the elimination of all demurrage in detained wood cars, reduction in storage and handling charges, increased tall oil and turpentine, or many other items.

These savings must be properly reflected in the cost of wood which includes the cost of forest management. It is *only* in the forest that such savings can be created. They must become part of the yardstick with which we measure the success of our performance. Forest investments must be related to additional mill profits or the incentive for such investments becomes confused.

Growth of Thinned Ponderosa Pine in Western Montana

A. R. Stage[1]

Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture

WHAT CAN BE expected from thinning dense young stands of ponderosa pine? Does thinning increase gross or net increment per acre, height growth, or diameter growth? Does the response vary on different sites? The growth observed on three series of thinning plots established in 1933 and 1935 by the Northern Rocky Mountain Forest and Range Experiment Station[2] indicates some of the answers to these questions for western Montana. Diameter, height, and cubic volume growth were improved by thinning, but the response varied by sites.

Description of Study

Two sets of plots are located near Frenchtown and the other set near Ninemile. The average site index of the Ninemile location was 68 feet at 100 years, or class V. The reproduction followed a clearcut logging operation. The stand prior to thinning had approximately 2,600 trees per acre with an average diameter of 2.6 inches. The equivalent basal area normality was 77 percent at an age of 33 years. One degree of thinning which reduced the basal area by 17 percent was used at Ninemile (plots 616 and 618). Plot 617 was left unthinned.

The Frenchtown stands were about 15 years older and on poorer sites than those at Ninemile. The area had been cut over in the late 1880's. The resulting reproduction was dense—approximately 100 percent of normal basal area stocking. Three intensities of thinning designated light, medium, and heavy were assigned to the thinned plots (604-606) on the better site (64) at Frenchtown. Plot 607 on the same area remained unthinned. On the poorer site (43) two intensities of thinning, light and heavy, with two replications each, were assigned to plots 609-612. Plot 613 was not thinned.

The age at time of thinning, site index, plot area, stand data, and thinning treatment are listed for each plot in Table 1.

Gross Basal Area Increment

On each of the three sites, the average gross basal area increment of the thinned plots exceeded that of the check plot for the 20-year period. On the poorest site the heavier thinning resulted in the maximum increment, while on the better site the medium thinning produced higher basal area increment. The mean annual increment is summarized in Table 2 by site and treatment.

Gross Cubic Foot Increment

The patterns of gross cubic foot increment were very similar to those of gross basal area increment. However, the relative differences due to site were more pronounced. The gross volume increment attained over the 20-year period is indicated in Figure 1 by the length of the vertical bars. The cross-hatching subdivides the increment into 5-year periods (except that

[1]Forester, Division of Forest Management Research, Inland Empire Research Center, Spokane, Wash.

[2]The Northern Rocky Mountain Forest and Range Experiment Station was consolidated with the Intermountain Forest and Range Experiment Station in 1954.

TABLE 1.—DESCRIPTION OF FRENCHTOWN AND NINEMILE PONDEROSA PINE THINNINGS

Plot	Age at establishment	Site index 1953-55	Area	Before thinning			After thinning			Description of thinning
				Mean d.b.h.	No. of trees	Basal area normality	No. of trees	Basal area normality: At thinning	Basal area normality: After 20 years	
	Years		*Acres*	*Inches*		*Percent*		*Percent*	*Percent*	
					Frenchtown					
604	50	64	0.15	3.5	2,647	104	853	59	106	Medium[1]
605	50	63	.20	3.6	2,205	94	790	60	90	Medium
606	50	67	.40	3.5	2,433	92	425	43	78	Heavy
607	50	60	.15	3.8	2,213	103	Check plot		102	Unthinned check
							800	63	72[2]	Check for medium
							540	48	55[2]	Check for heavy
608	50	64	.20	3.7	2,960	130	Check plot		140	Unthinned check
609	45	47	.15	2.4	4,007	88	1,706	71	101	Light
610	45	40	.15	2.1	5,100	93	1,993	68	94	Light
611	45	45	.15	2.5	3,720	93	753	46	78	Heavy
612	45	45	.15	2.3	4,360	92	900	44	82	Heavy
613	45	40	.10	1.9	6,930	101	Check plot		112	Unthinned check
							1,990	68	89[2]	Check for light
							1,050	45	60[2]	Check for heavy
					Ninemile					
616	33	67	.40	2.5	2,610	69	742	43	72	Heavy
617	33	65	.40	2.6	2,850	85	Check plot		96	Unthinned check
							935	49	60[2]	Check for heavy
618	33	71	.40	2.8	2,368	76	735	51	68	Heavy

[1]Early beetle-caused mortality reduced the density of this plot from a light to a medium degree of thinning.

[2]Residual trees if plot had been thinned.

TABLE 2.—PERIODIC ANNUAL INCREMENT PER ACRE OF BASAL AREA AND VOLUME FOR FRENCHTOWN AND NINEMILE PONDEROSA PINE THINNING PLOTS

Average site	Treatment	Periodic annual increment in basal area		Periodic annual increment in volume	
		Gross	Net	Gross	Net
		Square feet		*Cubic feet*	
68	Heavy	3.48	3.18	75.9	72.6
	Check	3.45	2.90	79.7	75.5
64	Heavy	3.35	3.15	85.4	80.2
	Moderate	3.70	3.42	87.4	83.6
	Check	3.18	1.02	77.7	42.3
43	Heavy	2.68	2.68	45.2	45.0
	Light	2.45	2.42	45.3	45.0
	Check	2.15	1.35	33.6	29.8

the second remeasurement was omitted on plots 616-618).

In a detailed analysis of the differences in cubic foot increment between the thinned and check plots for each of the remeasurement periods, the following relationships became apparent:

1. Average increment of the thinned plots on site 43 was 34.5 percent greater than increment on the unthinned plot on this site. Average increment of thinned plots on site 64 was 11.7 percent greater. These differences were statistically significant. There was no significance statistically to the small excess increment on the check plot over the thinned plots on the best site (68).

2. Where intensities of thinning could be compared, i.e., heavy vs. light on site 43 and heavy vs. medium on site 64, there were no significant differences in response.

3. Interaction of period of measurement with sites 43 and 64 was very significant. That is, the growth trend by 5-year periods followed different patterns on the two sites. This interaction was also evident in rates of diameter growth.

Net Cubic Foot Increment

Thinned vs. unthinned stands.—Net cubic foot increment of the thinned stands exceeded that of the unthinned stands on the two poorer sites. The percentage of net unthinned stand increment ranged from 230 percent in a medium thinning on site 64 down to 132 percent on a light thinning on site 40. As with gross cubic foot increment, there were no consistent differences between intensities of thinning.

On the best site (68) the two thinned stands made net increments of 103 and 89 percent of the unthinned. As these stands before thinning were stocked with only 69 to 85 percent of normal basal area, the differences between thinned and unthinned plots are here compared at a density level corresponding to the comparison between intensities of thinning on the other two series.

Optimum level of growing stock.—What can these plots tell us concerning the optimum growing stock for maximum net cubic-foot treatment? There are too few plots to define the shape of the curve of increment over density closely enough to locate directly the maximum point. However, by transposing the variables so as to define a straight line, the position of the maximum point can be determined objectively. The method of analysis is illustrated in Figure 2. The left axis represents the 20-year net volume increment divided by the basal area normality of the stand after thinning. The horizontal axis is a logarithmic scale of basal area stand normality after thinning. The two descending straight lines are drawn through the points representing the two Frenchtown sites.

When the increments per unit of normality indicated by the straight lines are multiplied by their corresponding normalities, the curves which are convex upward result, with units indicated by the scale of the right axis. Their maxima are indicated by arrows. The series of plots on site 64 appear to reach a maximum net cubic foot volume increment over a 20-year period at 62 percent of normal basal area, and the poorer site 43 reached a maximum at 54 percent of normal over a 20-year period after thinning.

The straight lines can be determined by solving the linear regression equation:

$$I/N = a + b \log N$$

where I = 20-year net cubic foot increment

N = normality after thinning

a, b = constants to be determined.

The maximum point of this equation multiplied by N is indicated by the formula:

$$\text{Maximum log } N = -\frac{a}{b} - .4343.$$

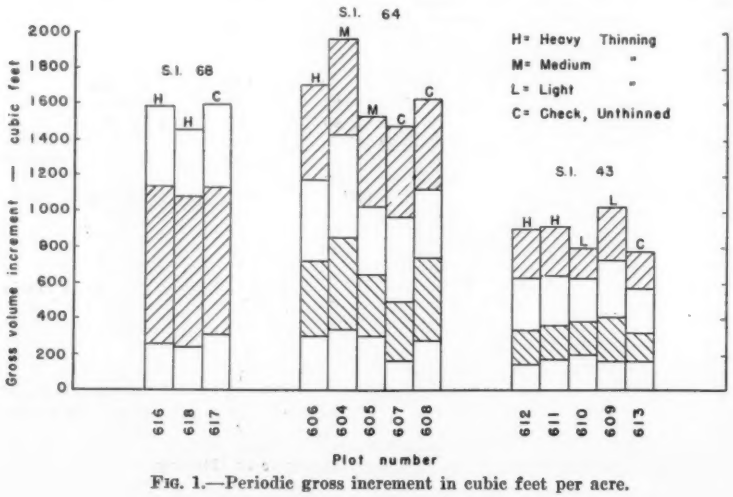

FIG. 1.—Periodic gross increment in cubic feet per acre.

Since both a and b are subject to experimental error, the maximum point is only an estimate. With so few replications, the fiducial limits would be rather wide.

Hence it appears that at basal area stocking levels of from about 45 to 70 percent of normal, stand density does not affect markedly either gross or net cubic foot volume increment. With stands stocked at normal or above basal area, however, thinning increases net cubic foot increment and there appears to be an increase in gross cubic foot increment as well.

Volume Production of Comparable Trees in Thinned and Unthinned Stands

Thinning concentrated the site productivity on the smaller number of trees left after thinning. The greatest concentration was effected on the better site at Frenchtown, which had a high initial density. There was also a substantial effect on the poor site. The Ninemile plots did not show as marked a response as the good site at Frenchtown because of the lower stocking prior to thinning at the former location. As would be expected, the heavier thinnings showed the greater effects. Table 3 lists these percentage relationships by site and degree of thinning.

Diameter Growth of Dominant and Codominant Trees

That thinning increases diameter growth is a corollary of the concentration of site productivity on the remaining trees. However, although the greatest percentage concentration was achieved on the better sites at Frenchtown, the greatest percentage response of diameter growth occurred on the poorer sites. The more heavily thinned plots showed the greater response.

The mean diameter growth of the dominant and codominant crown classes is shown in Figure 3 as a percentage of the growth in the same crown classes on the check plots. The difference in magnitude and duration of the response so expressed is evident. The response was more immediate on the better sites, but more prolonged on the poorer sites. These characteristics may reflect the ability of the trees on the better sites to occupy more quickly the space released in thinning.

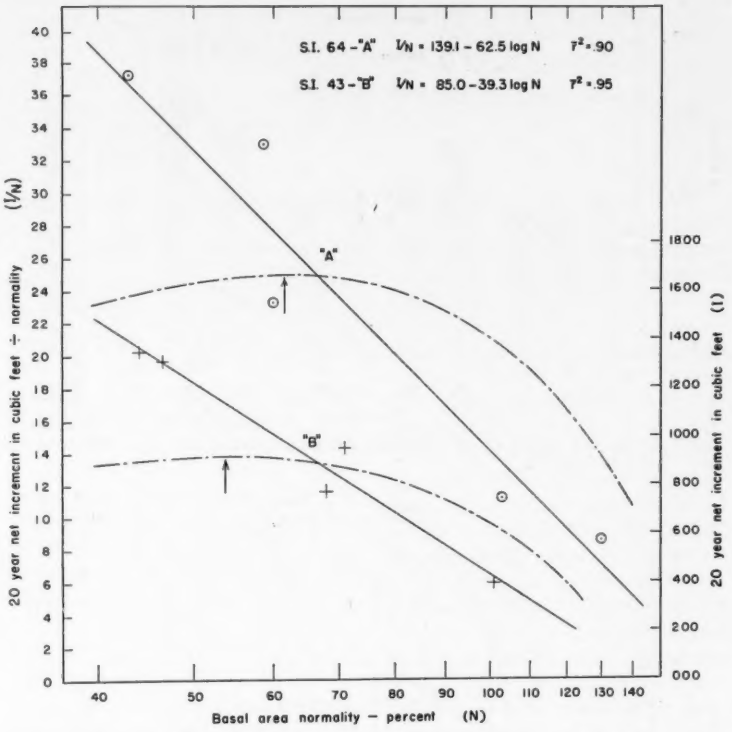
S.I. 64 - "A" V/N = 139.1 - 62.5 log N r² = .90
S.I. 43 - "B" V/N = 85.0 - 39.3 log N r² = .95
"A"
"B"
20 year net increment in cubic feet ÷ normality (V/N)
20 year net increment in cubic feet (I)
Basal area normality — percent (N)

FIG. 2.—Relation of net cubic foot increment to basal area normality, Frenchtown plots.

Comparing the actual mean d.b.h. growth on the two Frenchtown sites for successive remeasurement periods gives an interesting insight into the interaction of site and climate. The 5-year interval, 1938-1943, was the period of most rapid diameter increase on the best site, but the next to the slowest on the poorer site. This relation is shown in Figure 4 for the check plots only. The trends of the thinned plots paralleled those of the checks, indicating that this was not a chance "happenstance" on a single plot.

One explanation of such a pattern on sites of close proximity is that the intervals between precipitation were such that soil moisture became deficient during the growing season on the poor site but not on the better site.

TABLE 3.—GROWTH OF THINNED PLOTS AS A PERCENTAGE OF THE GROWTH OF A COMPARABLE PORTION OF THE UNTHINNED PLOTS[1]

Site	Degree of thinning	Net cubic foot increment compared to unthinned plot
		Percent
68	Heavy	135
64	Heavy	317
	Moderate	280
43	Heavy	187
	Light	138

[1]Trees that would have been cut in thinning were so designated on the check plot records when the plots were established.

Height Growth of Dominant and Codominant Trees

The height growth of those dominant trees on which height measurements were taken was subjected to an analysis of variance on each series of plots comparing all thinned with unthinned plots. Height measurements on plots 616-618 for 1935 were in error, so 1940-1955 height growth was used in this series. In every case, the mean height growth of the thinned plots

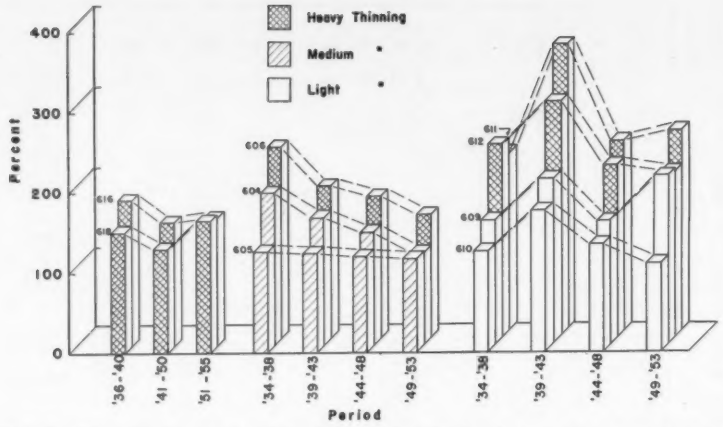

FIG. 3.—Diameter increment of dominant and codominant trees as a percentage of their unthinned checks.

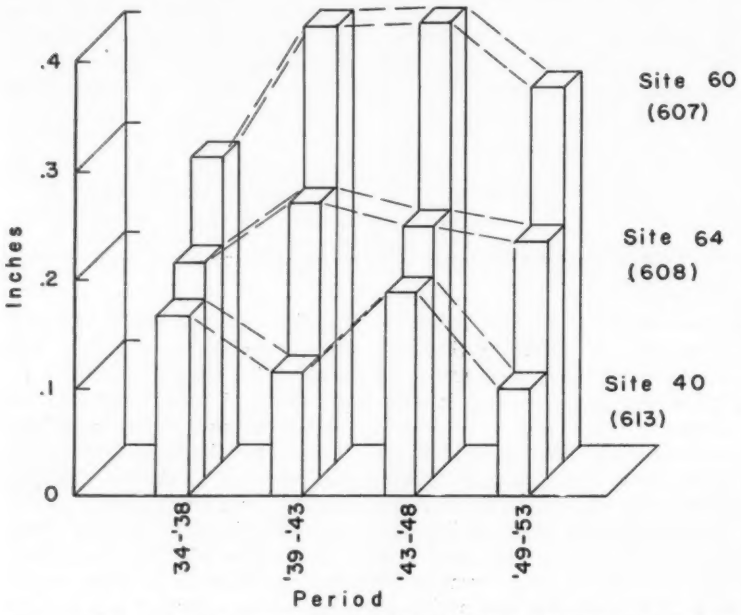

FIG. 4.—Periodic diameter growth rates of unthinned plots on adjacent areas of varying site index.

was significantly greater than that on the unthinned plots. The percentage differences were as follows:

Site 68	+ 31 percent	15 years
Site 64	+ 24 percent	20 years
Site 43	+ 19 percent	20 years

Site indices at the time of thinning were compared with the indices at the last remeasurement period to test whether the differences in height growth were due to site differences between thinned and unthinned plots. Changes in indicated site index were small—a maximum of plus 5 feet in 15 years on plot 616. However, the site indices of the unthinned plots decreased relative to the thinned plots in each series. Therefore, the increase in height growth is an effect of thinning. This effect complicates site determination in thinned stands.

Future Thinning Opportunities

Are these stands ready for another thinning? To continue their maximum productivity, they need thinning now. The present basal area normality (Table 1) of light and medium thinnings is about 97 percent. The heavily thinned plots now have 70 to 80 percent of normal basal area. While these stands certainly are in no danger of stagnating, their diameter growth rates (Fig. 3) are declining, and they are at a density where their net cubic foot increment is well below the maximum (Fig. 2).

Unfortunately, the trees that would be removed in a second thinning are not yet merchantable. A crown thinning would remove material averaging 6 inches d.b.h. on the better sites and 4 inches on the poorer. Therefore, the decision in favor of a second precommercial thinning rests on a management rather than a silvicultural basis. From a business view, the increased present value of earlier maturation must be weighed against the present cost of the thinning.

Summary

Ponderosa pine in western Montana showed a marked increase in diameter growth following thinning. This response was more immediate, though in a less degree, on better sites than on poorer sites. Net and gross cubic foot increments averaged greater in the thinned stands than in the unthinned stands of near normal density. Density following thinning showed a small effect on gross and net cubic foot increment with a maximum net increment at about 45 to 70 percent of normal basal area. Height growth of the dominant and codominant crown classes was significantly increased by 19 to 31 percent following thinning.

Notes

Shortleaf Versus Loblolly Pine in North Mississippi

Twenty-three-year-old loblolly pine (*Pinus taeda* L.) plantations growing in north Mississippi have produced 13 cords more wood per acre than adjacent shortleaf pine (*Pinus echinata* Mill.) plantations of the same age.

Shortleaf pine is the only pine native to much of north Mississippi and was the principal species planted during the 1930's. Since 1940, however, loblolly has been favored more and more, until today virtually no one plants shortleaf. The study reported here illustrates some of the reasons for this trend.

In the early spring of 1936 the Southern Forest Experiment Station established twenty plantations, ten of loblolly and ten of shortleaf pine, on deep brown loam soils in Benton County, Mississippi. Crew, planting method, and grade of stock were the same for each plantation. Each planting originally contained 150 trees in six rows of 25 trees. Spacing was 5 by 5 feet. Each shortleaf plantation was paired with an adjacent one of loblolly, pairs of plantations being separated by idle strips 33 feet wide.

These plantations were first cruised in March 1948 and an interior 1/20-acre plot (4 rows by 21 rows) on each was reinventoried in September 1957. Results of these two cruises are summarized in Table 1.

The survival of shortleaf pine has been superior to that of loblolly. A sleet storm in 1947 damaged the loblolly far more seriously than the shortleaf and is largely responsible for the death of over 300 loblolly during the last ten years. Many of the dead and dying trees could have been salvaged by an early pulpwood thinning. Nevertheless, the 712 loblolly trees per acre living in 1957 are more than enough to provide periodic cuts for many years to come.

Both the loblolly and shortleaf plantations should have been thinned at age 13. All plots were badly overstocked at age 23. Basal areas were phenomenal, averaging 231 square feet per acre, but some of this unusually good growth must be attributed to the unplanted areas around each of the plantations, from which trees along the edge could draw much of their sustenance.

At age 23 the tallest loblolly trees were 63 feet in height, the tallest shortleaf 48 feet. Indicated site indices were 98 for loblolly and 73 for shortleaf. This site is considered outstanding for loblolly and fair for shortleaf in north Mississippi. Some of the differences in height and indicated site index are due to the fact that tip moths (*Rhyacionia frustrana* Comst.) attacked and killed back the leaders of shortleaf far more severely than those of loblolly.

Because of their greater diameter and height growth, the loblolly pines have produced 30 percent more merchantable wood to a 3-inch top diameter (inside bark) than the shortleaf pine. Loblolly grew 2.5 cords per acre per year, shortleaf 1.9 cords. Annual growth of one cord per acre is considered good, two cords excellent in this area. During the last 10 years the shortleaf plantations have gained on the loblolly, mainly because they have more living trees per acre.

All plots were marked for thinning in 1957. The cut averaged 22.6 cords per acre in the loblolly plantations, 19.2 cords per acre in the shortleaf. Since the wood sold for $5.70 per cord, the gross annual return per acre now stands at $5.64 for the loblolly plantations and $4.76 for the shortleaf. The next thinning, to be made five years from now, will yield some small sawlogs as well as a good cut of pulpwood.

The experience recorded here has been noted in a general way in other loblolly and shortleaf plantations in northern Mississippi and in western Tennessee as well. The forester's preference for loblolly pine is understandable. However, shortleaf also has done well and would be a good species to plant in areas where sleet storms are prevalent and early tip moth damage is not a problem.

H. L. Williston
Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture

Table 1.—Stand Characteristics Per Acre of the 13- and 23-Year-Old Plantations

Item of comparison	Loblolly pine		Shortleaf pine	
	13 yrs. old	23 yrs. old	13 yrs. old	23 yrs. old
Trees living (No.)	1,028	712	1,098	1,064
Survival (percent)	59	41	63	61
Basal area (sq. ft.)	189	231	132	231
Avg. ht. dominants (ft.)	34	63	23	48
Site index (ft.)[1]	—	98	—	73
Avg. d.b.h. (in.)	5.8	7.7	4.7	6.3
Volume (cu. ft.)	1,506	4,400	623	3,369
Volume (cds.)	19.9	58.3	8.2	44.6
Growth/year (cords)	1.5	2.5	.6	1.9

[1]Coile, T. S., and Schumacher, F. X. Site index of young stands of loblolly and shortleaf pines in the Piedmont Plateau region. Jour. Forestry 51:432-435. 1953.

The Use of Tetrazolium for Quick Germination Tests

The main object of any method of seed testing is to arrive at an indication of how many seeds in a certain sample can be counted on to produce plants.

The objective might be to determine density of sowing in the nursery or seed spotting directly in the field. These statements might appear to be rather elementary, but they should be remembered. Sometimes, we think, too much time and money is spent on unnecessary germination tests, when the accuracy of the results were influenced by the selection of the sample and the future use of the seed is undetermined.

Many germination tests progress over a period of 12 weeks or more. This procedure takes a lot of time and equipment and is, of course, expensive. There is also the possibility that during this long period something can go wrong, either with the equipment or the operator. The final results are, in most cases, very accurate, but then again, it is questionable whether this accuracy is required in general nursery work and field spotting. In controlled germination tests the germinative capacity is perhaps the utmost potential that can be expected from a certain lot of seed under the most favorable conditions. These results are too optimistic for the ordinary nurseryman or forester. Germinative energy approaches an understandable and more realistic answer.

The need for a quick and reliable indication as to seed quality has been appreciated for many years. In 1929 the Russians used the Indigo Carmine test. This test was, as a whole, successful with quick germinating seed. Between 1929 and 1942 many other biochemical tests for seed germination were used. In 1942 Lakon produced the Tetrazolium test. This test depends on respiratory and enzyme activity for its effect. In contact with living cells the colorless Tetrazolium solution is reduced to an insoluble red dye. This solution is very sensitive to light. The solution is however, nontoxic and results can be obtained within 24 hours. Much work has been done by the Boyce Thompson Institute with Tetrazolium dyes on forest tree seed. It is not our intention to explain the techniques of the Tetrazolium test, as the product can be purchased under a trade name and detailed instructions are enclosed in each package. However, we would like to point out, that it takes considerable experience to determine to what degree the surfaces of the seed should be stained in order to meet the qualifications for a living seed. We have found, in most cases, in the forest tree seeds that a strongly and completely stained surface will meet the requirements for field germination. In the case of Jeffrey pine seed we have found that the entire surface does not need to be stained; perhaps 2/3 or less indicates that the seed will meet the field germination requirements.

The results obtained by the Tetrazolium test and by controlled germination are illustrated on the graph. No attempts have been made to analyse the results statistically, and consequently the bar graph illustrates the actual results regardless of variations in sampling and procedures. The results obtained by the Tetrazolium are in close agreement with the germinative energy obtained in controlled germination tests. It is debatable what accuracy should be expected or is required. Probably the nurseryman will only alter his rate of sowing, even up to 15 percent. The Mt. Shasta Nursery has been using the Tetrazolium test since 1950 and we are very well pleased with the good results and economical performance and the resulting savings in time and money.

KARL B. LANQUIST, *Forester*,
and RUTH A. DRAGOO,
Mt. Shasta Nursery, U.S. Forest Service, McCloud, Calif.

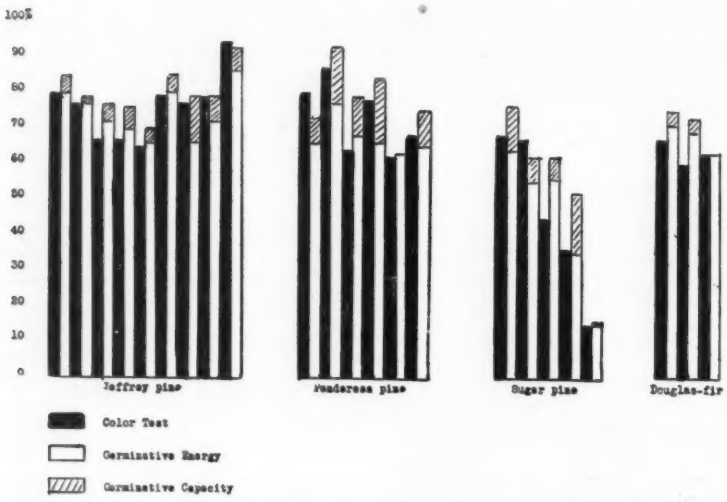

FIG. 1 — Seed tested with Tetrazolium and seed tested by controlled germination. Samples are arranged from left to right. Left bar is the Tetrazolium test and the right bar, controlled germination. Each set selected from the same seed sample.

How Much Douglas-Fir Will Grow on an Acre?

Timber stands of 390,000 board feet per acre are rare, even in the virgin forests of the Pacific Northwest. However, this volume of Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) is growing on a measured acre in the Willaby Creek Recreational Area of the Olympic National Forest, near Quinault, Washington. Though neither the oldest nor the largest of the species, the trees are a striking display of vigor and height even in this region of tall, coniferous forests.

In 1948, W. E. Hiley and H. G. Champion, while visiting the area, suggested that an exact record be made of the near-maximum productivity of an acre of Douglas-fir. This record in turn might stimulate similar measurements for other principal forest types of the world.

As a result of their suggestion, an acre plot was laid out within the densest part of the grove in such a way as to encompass the maximum possible number and volume of trees. This acre (208.7 feet square) lies at an elevation of 280 feet on a level bench 90 feet above Lake Quinault. The soil is a deep, well-drained, loamy sand. Mean annual temperature for the area is approximately 50° F.; average monthly temperature varies from a low of 40° in January to a high of 60° in July and August. Mean annual precipitation is 125 inches, with 30 inches falling during the growing season (April-September). Such abundant precipitation, good soil drainage, and moderate, humid climate are ideal for tree growth.

The stand (Figs. 1 and 2) consists of a Douglas-fir overstory with a developing understory of western hemlock. All Douglas-firs are sound and in vigorous condition, although height growth has apparently ceased. Boles are straight but not particularly smooth, and there are no remnants of dead or down material. A replica of this area (known as the Olympic Forest Diorama) is on exhibition in the Hall of North American Forests of the American Museum of Natural History in New York City.

If cut, the stand would yield an estimated 30 percent of high-grade veneer logs 24 inches and larger in diameter. Diameters of the Douglas-firs at breast height ranged from 46 to 78 inches, averaging 62 inches. Average diameter of the hemlock was 20 inches. Further statistics for the acre are given in Table 1.

It is notable that the mean annual increment for the acre—1,041 board feet—is 82 board feet more than for a normal site I, 160-year-old stand.[1] Apparently, the stand has maintained a high growth rate throughout its life.

It should be clearly understood that this example represents an extreme case of high productivity.

[1]McArdle, Richard E., W. H. Meyer, and Donald Bruce. The yield of Douglas-fir in the Pacific Northwest. (Table 9.) U. S. Dept. Agric. Tech. Bul. 201, 74 pp., illus. Rev. 1949.

FIG. 1.—Uniformity in size and density are characteristic of the Douglas-fir in this stand. The smaller understory trees are western hemlock. Note the carpet of Oregon oxalis in the foreground.

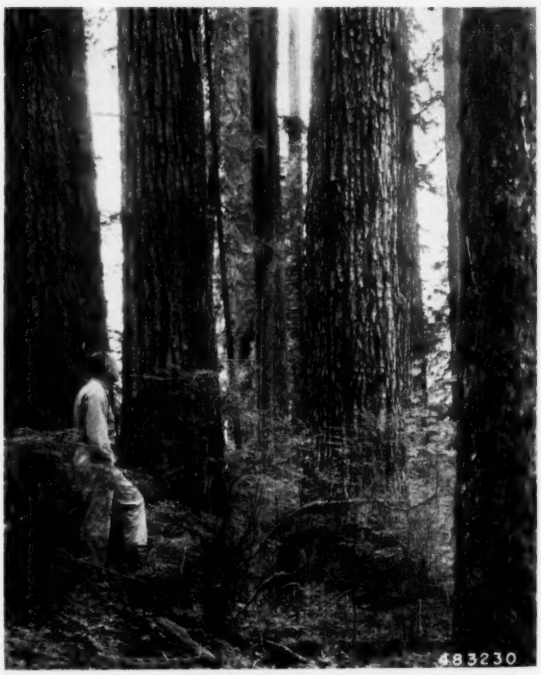

FIG. 2.—Close spacing of the Douglas-fir is particularly striking. The prominent shrubby vegetation is whortleberry.

TABLE 1.—STAND STATISTICS FOR A SELECTED ACRE OF OLD-GROWTH TIMBER IN THE DOUGLAS-FIR TYPE, OLYMPIC NATIONAL FOREST, WASHINGTON

Item	Douglas-fir	Western hemlock	Total
Estimated stand age (years)	375	150	---
Height of stand (feet)	285	100-175	---
Site	I	---	---
Stems (number)	31	28	59
Basal area (sq. ft.)	656	58	714
Volume:[1]			
Cubic feet	49,625	3,155	52,780
Board feet (Scribner Rule)	371,820	18,370	390,190
Mean annual increment:[1 2]			
Cubic feet	132	8	140
Board feet (Scribner Rule)	992	49	1,041

[1]To convert cubic feet and board feet to cubic meters per hectare, multiply by 0.070 and 0.012, respectively.
[2]Western hemlock increment is computed on the same basis as Douglas-fir increment.

Other areas of greater volume may exist in the Douglas-fir type, but few would show such volume at 375 years. It is hoped that this example may stimulate other foresters to investigate and report the maximum acre yields of other forest types in their areas.

NORMAN P. WORTHINGTON
Puget Sound Research Center, Pacific Northwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture

The Extraction of Large Wood Samples from Living Trees

FIG. 1.—The sample being removed from the tree.

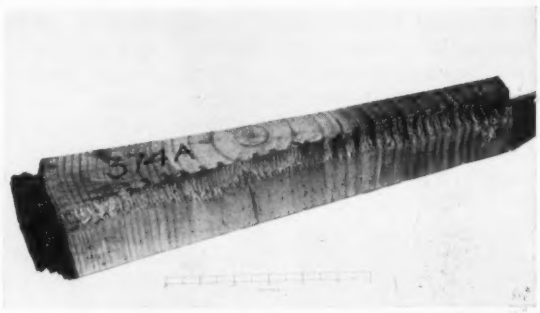

FIG. 2.—The extracted sample. (*C.S.I.R.O. Photo*)

In the course of recent work at the Forestry and Timber Bureau, Canberra, Australia, the need arose to obtain some large wood samples from elite trees of *Pinus radiata* in order to evaluate a number of wood characteristics. The 0.45 inch cores provided by a large increment borer were inadequate for this purpose.

Echols and Mergen[1] described a method whereby they obtained samples ½ x 1⅛ x 8 inches in size running from the bark to the pith in *P. elliotti* v. *elliotti*. It was decided, in this instance, however, that larger samples having a minimum cross section of 2 x 1 inches from bark to pith were desirable. The large diameter of the trees concerned, up to 20 inches, and the frequent eccentricity of the pith, made it difficult to be certain that the pith would be included in a small sample.

The method adopted may be of interest to other workers, and is therefore described.

Three holes as in Figure 1 were bored right through the tree with a ¾-inch auger bit, in the plane of the lean of the tree at a height of about 3 feet, 6 inches above ground level. The sample was then cut out using a modified bow saw. The 1 inch wide blade was reduced to 0.7 inch in width with a pair of tinsnips to enable it to be threaded through the ¾-inch holes. Two fittings, shown in Figure 1, allow the blade to be turned through an angle of 90° to the normal plane so that the vertical cuts could be made. The cuts were made as indicated by arrows. While it is theoretically possible to use only two diagonally-opposite holes, it was found more convenient to use three as illustrated, making both vertical cuts in a downward direction.

The sample obtained is illustrated in Figure 2.

The cavities were subsequently treated with preservative and plugged to prevent insect and fungal attack and to assist healing.

The time required for the operation varied with tree size, but the average was of the order of one hour.

A. G. BROWN
Forestry and Timber Bureau, Canberra, Australia

[1]Echols, R. M. and Francois Mergen. How to extract large wood samples from living trees. *Jour. Forestry* 53:136. 1955.

Forestry Education in Spain

Spain is fortunate in having had a school of forest engineering since 1848. During the last half of the nineteenth century, when her forest resources were under double pressure from both agriculture and industrial development her Corps of Foresters, trained at this school, seems to have been nearly the only bulwark against a tide which nearly did away entirely with her forest resources. Following the political theories in vogue in the day, successive liberal governments were ordering the sale at auction of public lands whether suitable for agriculture or not. In 1863, the Corps of Foresters succeeded in exempting pine, oak, and beech forests over 100 hectares in area. This basic law salvaged what little natural forest Spain now has left.

Spain has still another reason to be thankful for this school. Although at first their work must have seemed ineffectual and almost hopeless, the graduates were, decade after decade, slowly building up a body of knowledge and a professional tradition that are at last coming into their own. Soon after Spain's Civil War, the government undertook a program of replanting the idle, devastated lands that amounted to about half the area of the country. From a modest start in 1940, the program is now adding a quarter of a million acres a year of new forest to the country's natural resources. It is one of the most ambitious, extensive, and successful reforestation programs in Europe. The backbone of it has been the Corps of Foresters trained at the forestry school.

The founder of the school was Don Bernardo de la Torre y Rojas, a man of considerable and diverse talent. A cadet at twelve and an officer at sixteen, he had seen plenty of action against the French by the time he arrived in South America to fight against the revolutionary armies of Bolivar and O'Higgins. Thrice decorated and minus an arm, he escaped from a Chilean prison camp and made his way back to Spain, to serve another 14 years as a cavalry colonel before retiring in 1832. In the meantime he had managed to study law, and had before him a career as an attorney, diplomat, judge, statesman, and, finally, educator.

What exactly drew this remarkable man toward forestry is hard to say. Obviously he had many interests; and among them he must have had a vision, almost a century ahead of his countrymen, of a time when they would recognize the forestry problem, and would clamor for the trained skill and dedication of foresters. His interest was not so much in silviculture as such, for it hardly existed at the time, as in public administration. He realized clearly that the government needed corps of trained engineers to carry out the new functions demanded by the liberal and industrial trends following the French Revolution. War, religion, and trade were no longer the principal interests of the state. Agriculture, communications, and natural resources were coming to the fore. The state was training naval, mining, and highway engineers already. De la Torre insisted that foresters were needed also; and being a man of high connections and extraordinary perseverance, he won his way.

The purpose of the school, then, was to provide the state with a body of trained servants who could deal with the ever recurring and bothersome problem of the public lands. These had increased enormously since the seizure of church property in 1836. In view of this purpose, it is not surprising that the three-year training of these first forestry engineers was principally in mathematics, surveying, mapping, and incidentally, silviculture. Their duties at first were, not to manage forests, but to identify and map pieces of timbered land with a view to saving them from the public auction block.

A century ago, then, the public lands were moving into private ownership as fast as they could be sold; and forests were being cut as never before. Such policies and trends could scarcely have made an encouraging atmosphere for the young profession. Yet just such conditions have forged forest policy and nurtured the profession in country after country.

The small amount of silviculture then taught was purely German in origin. During the 1840's, two Spanish students had studied at the famous school of Henry Cotta at Tharand, in Saxony. Both became imbued with his theories of managed forests, and both became professors at the new school. German was required for admission, and Cotta himself was something of a patron saint.

The school underwent many vicissitudes during the first century. At first it was located in the half-ruined castle of Villaviciosa (roughly translated "Bad Town") near Madrid. After two decades it moved to El Escorial and thence, in 1914, to Madrid. Here it struggled with the problems of cramped quarters and inadequate grounds for field training. A crowning and nearly fatal blow occurred during the siege of Madrid in 1936. Then a shell made a direct hit on the building, and in the resulting conflagration, it was completely destroyed along with all equipment, collections, and a library of 30,000 volumes.

Soon after the cessation of hostilities in the spring of 1939, the nationalist government of General Franco began the task of rebuilding the University City on the outskirts of Madrid, which had also been destroyed. A school of forestry was included, and in October 1945 the new building was dedicated. It stands amid 200 hectares of plantations, and leaves little to be desired in the way of classroom, library, or laboratory facilities. Organizationally, it is an independent unit within the Ministry of Education, and not attached to the University of Madrid.

This school is an outgrowth of the European tradition of higher learning; and, as such, it differs considerably from American

schools. In round terms, it may be said that our American system is an open one, wherein anyone is free to study and find his own level in or out of the profession as his interests and abilities may dictate. We are not concerned that graduates must find or create their own jobs after school, and that many find work in other fields. We are inclined to consider therein the marks of an expanding and mobile society.

In Spain, by contrast, the objective of technical education is to provide the state with a limited number of highly specialized and dedicated public servants. Theoretically at least, each student has a position waiting for him from the day he is admitted. State employment, particularly at the professional level, is held in great respect and is much sought after. Hence the forestry graduate is sure of an honorable and steady employment. Nor is he necessarily barred from a business career at the same time.

Spain's forestry school reflects very strongly these facts in every phase of its operation. The professors, for example, who number eighteen, are all employees of the Spanish Forest Service and graduates of the same institution. They serve the interests of the state first, and only incidentally those of private industry or landowners.

Graduates of high school can and do present themselves in large numbers for the entrance examinations. These are highly selective, and often aspirants study several years in private academies in hope of admission. For example, in the year 1947, 898 candidates took the examinations and 14 were successful. A more nearly average proportion is that of 1956 when one out of six were successful. A graduating class has consisted normally of about twenty, and the student body of 100 until the present year when 52 will receive degrees.

Once admitted, students follow 44 courses distributed over five years, rigorously concentrating upon scientific subjects. They do not specialize within the general discipline of forestry; they prepare a field project, but they take no general or cultural courses. Wildlife and range management appear in the curriculum, but recreation and other fringe subjects do not. Graduates become highly uniform and highly competent in the special problems of forestry in Spain. The extremely successful reforestation program now under way is convincing proof of the efficacy of the training they receive.

Nevertheless, a decree of July 20, 1957 promises some significant changes. The genesis of this decree is a concern felt in Spain, as in so many other countries, over the scarcity of technical personnel to man the growing industrial and social complex. In the case of forestry, it prepares to meet this need in several ways. First, the number of graduates each year has been raised from about twenty to fifty. A sixth year will be added for a doctorate degree, and specialization will be allowed at least to the point of concentration upon management or products. The stiff entrance examinations will be abolished. Instead students will be sifted out on the basis of probationary courses. The school will be associated with a high council of technical education with a view to breaking the barriers between the various technical schools.

Some conservative foresters shake their heads over such reforms and predict an overproduction of graduates and a lowering of standards. They prefer the tradition of secure employment and restricted membership. But their viewpoint will probably not win out in the long run. Spain needs foresters to plant and manage her 65 million acres of potential woodland. But she needs more than foresters; she needs men with vision enough to grapple with the over-all problems of range, wildlife, soil conservation, and watersheds as well as forests. She needs an educational policy of abundance as a first step in a better life for her people.

HENRY S. KERNAN
Chief forestry adviser,
U. S. Operations Mission,
Spain

Aids For Using Wedge Prisms

Wedge prisms are used for estimating basal area and volume of forest stands and for measuring distances.[1] The diopter strength of the prisms must be known so that factors can be calculated for basal area and volume estimations and so that targets of specified widths may be provided for distance measurements. Prisms of a desired strength to give conveniently-used factors, such as 10, 20, 30, 40, etc., may be obtained or they may be adjusted to desired strengths by proper mounting.[1,2] Factory-run prisms of stated diopter strengths are often precise enough for general work or they may be calibrated more accurately.[3] In either case, factors or target widths may be fractional numbers which complicate their use in the field. Two tables are presented which illustrate a method of facilitating the accurate use of wedge prisms.

Table 1 shows the cumulative values, to the nearest square foot of basal area, for different tree-tallies from a point and for prisms of different even-number diopter strengths from 2 to 8. Note that the basal area factors, shown in the first line, are fractional numbers. Referring to this table to convert a plot tally to square feet of basal area reduces arithmetic errors in the field. Such a table may be developed for prisms of any diopter strength or basal area factor.

Table 2 shows the width of targets needed to establish circular plots of different areas using prisms of different diopter strengths. Instructions for laying out circular plots and for calculating target widths are also shown.

A convenient target for use in laying out circular plots with a

TABLE 1.—BASAL AREA IN SQUARE FEET PER ACRE

No. of trees tallied from a point	Diopter strength of prism 2.0	3.0	4.0	5.0	6.0	7.0	8.0
1[1]	4.4	9.8	17.4	27.2	39.2	53.3	69.6
2	9	20	35	54	78	107	139
3	13	29	52	82	118	160	209
4	18	39	70	109	157	213	278
5	22	49	87	136	196	267	348
6	26	59	104	163	235	320	418
7	31	69	122	190	274	373	487
8	35	78	139	218	314	426	557
9	40	88	157	245	353	480	626
10	44	98	174	272	392	533	696
11	48	108	191	299	431	586	766
12	53	118	209	326	470	640	835
13	57	127	226	354	510	693	905
14	62	137	244	381	549	746	974
15	66	147	261	408	588	800	1,044
16	70	157	278	435	627	853	1,114
17	75	167	296	462	666	906	1,183
18	79	176	313	490	706	959	——
19	84	186	331	517	745	1,013	
20	88	196	348	544	784	1,066	
21	92	206	365	571	823	1,119	
22	97	216	383	598	862	1,173	
23	101	225	400	626	902	——	
24	106	235	418	653	941		
25	110	245	435	680	980		
26	114	255	452	707	1,019		
27	119	265	470	734	1,058		
28	123	274	487	762	1,098		
29	128	284	505	789	1,137		
30	132	294	522	816	1,176		

[1]Items in this line are "basal area factors" to the 1st decimal. Other entries in the table have been rounded to the nearest square foot.

TABLE 2.—USING PRISMS TO MEASURE DISTANCES

Prism strength	Width of targets to establish circular plots — Area of plot in acres 1/100	1/50	1/20	1/10	1/5	1/2	1
Diopters				*Feet*			
2.0	0.24	0.33	0.53	0.74	1.05	1.67	2.36
3.0	0.35	0.50	0.79	1.12	1.58	2.50	3.53
4.0	0.47	0.67	1.05	1.49	2.11	3.33	4.71
5.0	0.59	0.83	1.32	1.86	2.63	4.16	5.89
6.0	0.71	1.00	1.58	2.23	3.16	5.00	7.07
7.0	0.82	1.17	1.84	2.61	3.69	5.83	8.24
8.0	0.94	1.33	2.11	2.98	4.21	6.66	9.42
Plot radius	11.78	16.65	26.33	37.23	52.66	83.27	117.75

Prisms of known strength (diopter values) may be used to establish desired distances from a point. This principle is useful in timber cruising to check the boundaries of circular plots. Inclusion or exclusion of borderline trees may be determined quickly with a prism by observing a target of specified width in the center of the plot. Opposite sides of the target will be in line across the prism at the plot boundary.

Target widths required to establish desired distances are a function of the prism strength and the radius of a circle delineating the plot area. The following table gives target widths for several common prism strengths used in woodland work and for circular plots of sizes most generally desired. These have been calculated from the equation: $w = \frac{rd}{100}$ when: w = width of target in feet; r = radius of circular plot area in feet; d = *diopter* strength of the prism.

[1]Bruce, David. A new way to look at trees. Jour. Forestry 53:163-167. 1955.
[2]Gould, E. M. Jr. The Harvard Forest prism holder for point-sampling. Jour. Forestry 55:730-731. 1957.
[3]Bell, J. F., and L. B. Alexander. Application of the variable plot method of sampling forest stands. Ore. Sta. Bd. For. Res. Note 30. 22 pp. 1957.

prism can be made from a 5- or 6-inch diameter mailing tube or similar cylindrical item. The cylinder is cut off in the required length as shown in Table 2 and up-ended over a range pole or staff at the plot center. This target is viewed along the edge of the wedge prism held in a vertical position to locate the periphery of the circular plot.

The writer has found it convenient to place these two tables, reduced to about 3½ × 4½ inches, back to back in a transparent plastic cover and carry them in a packet with a collection of prisms. They may also be placed in the field notebook or fixed to the cover of the tatum holder.

PAUL E. LEMMON

Soil-woodland specialist,
Soil Conservation Service,
Washington, D. C.

Aerial Application of Benzene Hexachloride for the Control of Cone Insects on a Slash Pine Seed Production Area

In an effort to evaluate the effectiveness of aerial applications of benzene hexachloride to minimize cone losses to insects on seed production areas, Gair Woodlands Corporation, of Savannah, Georgia, began field tests of this technique in 1957. Aerial spraying was decided upon because it was felt that the acreage involved, the condition of the areas themselves, and the scattered nature of company lands would make the use of ground spraying equipment impractical.

A slash pine seed production area in Long County, Georgia, was sprayed with one gallon per acre of BHC (12 ounces of 36 percent iso-gamma BHC, or its equivalent, per gallon of oil) the weeks of February 25 and June 15, 1957, and February 17 and May 10, 1958. The cost for flying and the spray material was $3.09 per acre for each application.

Fifteen systematically selected trees were marked and climbed the week of April 7, 1957 (weather conditions and other work made earlier climbing impossible) and the new and 1-year-old cones on certain limbs were counted and the limbs marked. A check was set up on an unsprayed seed production area about two miles from the first area. Cone counts were made there the week of April 7 also. Counts were repeated on both areas in September 1957 and in March and May 1958.

Cone losses shown by the September 1957 and March 1958 counts did not differ significantly. The May 1958 counts showed highly significant differences in new cones in favor of spraying—7 percent mortality among new cones on the sprayed area and 31 percent mortality on the unsprayed check. There were not enough 1-year-old cones for a valid test of the spray's effect on them. Only one cone (about 0.5 percent) has been lost to cone rust each season.

We feel that the results to date indicate that this treatment is quite effective in reducing losses of new cones on the area treated. That the 1958 counts showed a significant difference between treatments while the 1957 counts did not is probably because the spray was more effective when, as in 1958, it was applied closer to the time of pollination. Since most of the damage seems to occur at about the time of pollination, we hope to get better results next year by spraying first about 10 days before pollination and again about a week after.

Dr. T. O. Perry of the University of Florida and Edward Merkel of the Southeastern Forest Experiment Station (Lake City Branch) have given us a great deal of help and advice. The flying was done by Scotair, incorporated, of Savannah, Georgia.

DONALD E. COLE

Forester,
Gair Woodlands Corporation

Points of View

Some Comments Regarding the Journal

As long as I can remember, the contents and editorial policy of the JOURNAL OF FORESTRY has been subjected to sporadic criticism. Some field foresters have complained that it is too technical; some research and school men have said that that it's not technical enough; a few utilization men have said it contains little that helps them; some silviculturists think it prints too much general policy material; and so on. Some of the latest "blasts" are quoted in the Central States Section Newsletter of June 1958.

The criticism poses some questions: What is the true function of a professional journal; specifically, what is the function of the JOURNAL OF FORESTRY? Can the JOURNAL please everyone or should it even try? These questions are particularly difficult because the JOURNAL OF FORESTRY serves so many rather widely separated fields. Note that it has 11 association editors in 11 separate fields ranging from forest genetics, through silviculture and forest management, to wildlife and range management.

A profession is usually regarded as an occupation based on a special body of knowledge and involving special mental or other attainments. The labor is usually considered to be more mental than manual and the "professor" is properly assumed to have a liberal education. Most foresters will agree that their occupation is a profession and the general public is coming to accept this view. If we are a profession, we naturally will want to act like professional men and help build up and communicate a body of knowledge upon which our profession can depend. It seems to me that the function of the JOURNAL is simply to (1) communicate professional knowledge and ideas to the people engaged in the profession, and (2) act as a "sounding board" and open forum to hammer out issues vital to the profession.

Now what about the 11 fields within the profession mentioned above? The SAF definition of forestry is: "The scientific manage-

SECTION BOX SCORE 1958 MEMBERSHIP

	Applications Received[1]		
	Oct. 1958	Total 1957	Total 1958
Allegheny	8	68	58
Appalachian	3	71	25
Central Rocky Mountain	0	24	15
Central States	3	30	22
Columbia River	1	55	51
Gulf States	13	84	56
Inland Empire	1	21	17
Intermountain	15	6	46
Kentucky-Tennessee	0	8	3
New England	0	62	44
New York	2	37	27
Northern California	1	39	12
Northern Rocky Mountain	1	49	26
Ozark	2	92	23
Puget Sound	1	61	48
Southeastern	17	132	110
Southern California	0	3	0
Southwestern	0	7	1
Upper-Mississippi Valley	10	69	74
Washington	0	10	1
Wisconsin-Michigan	12	84	83
Totals	90	1,012	742

[1]Student, Junior, Affiliate, Associate (Initial) grades only.

SCHOOL BOX SCORE 1958 MEMBERSHIP

	Student Applications Received		
	Oct. 1958	Total 1957	Total 1958
Alabama Polytechnic Institute	0	19	22
University of California	0	30	56
Colorado State University	0	19	15
Duke University	0	13	3
University of Florida	6	6	22
University of Georgia	2	86	45
University of Idaho	0	19	14
Iowa State College	0	35	21
Louisiana Polytechnic Institute	0	18	5
Louisiana State University	0	41	7
University of Maine	0	31	22
University of Massachusetts	0	10	4
Michigan Coll. of Mining & Tech.	0	29	5
Michigan State University	0	24	30
University of Michigan	1	14	18
University of Minnesota	1	28	32
University of Missouri	0	62	7
Montana State University	0	45	17
State University of New York	0	25	16
North Carolina State College	0	36	1
Oregon State College	0	29	30
Pennsylvania State University	0	32	24
Purdue University	0	18	18
Utah State University	0	5	24
University of Washington	0	27	27
West Virginia University	0	19	19
Yale University	1	7	6
Totals	11	727	510

ment of forests for the continuous production of goods and services." All 11 fields clearly fit within this definition. It seems then that the JOURNAL OF FORESTRY is right to publish articles in all these fields. Special journals within some of these fields are appearing, and rightly so, but as long as we accept the above definition of forestry, we cannot rightly criticize the JOURNAL for being too broad.

In communicating knowledge to the profession, is the JOURNAL OF FORESTRY too technical? (*Forest Science* prints most of the highly scientific material). It all depends on whether we want rather basic knowledge to help us *understand* what we are, or should be, doing, or whether we are satisfied with "how-to-do-it" prescriptions and "rules-of-thumb." A truly professional man must think, plan, and execute; usually in that order. Shouldn't a professional journal help provide the knowledge basic to these processes? I think it should and, all in all, I believe the JOURNAL OF FORESTRY has done a reasonably good job. Any weakness in the advancement of our profession or in the JOURNAL can be blamed chiefly on us, as members of the SAF, not on the JOURNAL itself. No professional journal can fulfill its function, or maintain its status and prestige, if it publishes mostly "how-to-do-it" type articles.

Why don't some graduate foresters like the technical articles in the JOURNAL OF FORESTRY? I have heard several reasons: (1) the information is not in their field and they are not interested, (2) they can't see the application to their work (too much theory), (3) for various reasons they don't trust the data or recommendations. I wonder if a failure to communicate through the JOURNAL is not partly the fault of the reader. We realize that all articles cannot be in our own field. We read those that contribute to our work or to an understanding of our field of work. Sometimes we are just interested in what the man has to say.

All research findings may not apply immediately to the job at hand. Maybe they point the way to new practices or to some concept heretofor unfamiliar to the practicing forester. Maybe they just show him *why* certain things do or do not happen. This has happened to all of us. Also, we may question what the author says. This doubting is a sacred right which should be guarded. However, we will cheat both ourselves and the author unless we receive what he has to say with an open mind and give it fair consideration.

Is the JOURNAL OF FORESTRY an effective "sounding board" for the profession? Has it been too cautious on controversial issues? These are touchy questions. Here again the profession will get what it wants and demands. Personally, I would like to see more lively and stimulating discussion of issues, whether or not they seem important at the time. Maybe something can be done about this and the proper place to begin is within the membership of our professional society. Would anyone else like to "sound off"?

Very truly yours,

LEON S. MINCKLER

Comments on "Effect of Soil Amendments on Growth of Shortleaf Pine"

It is encouraging to see the increasing number of articles on forest soil fertilization appearing in the JOURNAL OF FORESTRY. Interest is increasing rapidly in the possibility of using commercial fertilizers as a tool for improving growth conditions in our forests.

In their recent JOURNAL article Roth and Evans[1] quote some cost figures for the fertilizer materials that gave the beneficial growth responses. It should be pointed out here that the bulk of the nitrogen (160 pounds of N per acre) came from nitrate of soda which has the highest unit cost for nitrogen carriers. Nitrate of soda has been a very popular material in the South despite the high unit cost of nitrogen.

A unit is a term used to designate 1 percent of a ton or 20 pounds. Thus there are 8 units of N in the 1,000 pounds of nitrate of soda used in the experiment reported by Roth and Evans. The current cost per unit N in nitrate of soda is $2.94. The current cost per unit N in ammonium nitrate is only $2.15. For the amount of N applied by the nitrogen carrier alone this would represent a saving of $6.32 an acre by using ammonium nitrate instead of nitrate of soda. An additional saving would be realized in using ammonium nitrate which contains 33.5 percent N as compared to 16 percent N in nitrate of soda, in that less than half as much material (480 lbs. vs. 1,000 lbs.) would have to be handled. This could be a very important factor particularly in cases of aerial applications.

It is doubtful that even with the use of ammonium nitrate instead of nitrate of soda that fertilization would have been economically feasible under the conditions described by Roth and Evans. In future work, however, care should be exercised in evaluating the economics of the fertilizer applications to forest land. We may well cheat ourselves out of a useful silvicultural tool as a result of our lack of knowledge of fertilizer economics.

C. T. YOUNGBERG
Oregon State College, Corvallis

[1]Roth, Elmer R., and Thomas C. Evans. Effect of soil amendments on growth of shortleaf pine. Jour. Forestry 56:215-216. 1958.

Germination Conditions for Western Hemlock

I read with interest Dr. Te May Ching's paper in the April 1958 JOURNAL OF FORESTRY "Some experiments on the optimum germination conditions for western hemlock (*Tsuga heterophylla* Sarg.)."[1] This study relates closely to work done in my laboratory in recent

[1]Ching, Te May. Some experiments on the optimum germination conditions for western hemlock (*Tsuga heterophylla* Sarg.). Jour. Forestry 56:277-279. 1958.

years and is very similar to a study made by William Bientjes in 1954.[2]

Bientjes' results confirmed earlier work by the writer and indicated that soaking of hemlock seed for 30-36 hours, stratification ("naked") for 8 weeks (7-9 weeks), and incubation at 20°C. constant gave the fastest and most complete germination of the various combinations tried. The criterion adopted for the most satisfactory germination test was the above, with the axiomatic proviso that the results should be reasonably similar as among different seed lots, and reproducible.

Dr. Ching has introduced another concept, namely, that "simplicity and rapidity . . . are the essence of seed testing" and that, therefore, "the *optimum germination condition* for western hemlock appears to be germinating seed for five weeks without soaking or stratification at 20°C. with supplemental light" (italics mine). By "rapidity," the author refers to the *total* time required for complete germination, and includes stratification time. Furthermore, the author states in the beginning that "the evaluation of a seed lot . . . requires skill and *optimum growing conditions* to obtain a representative and valid measure of its potentiality" (italics mine).

I seriously question the author's use of "optimum" in both of the quoted statements. Stratification is a *pretreatment* and not a *growing condition* and the time in days given to stratification should not be added to days of incubation to give a measure of rate of germination, or "rapidity" as it is termed. The author's figures (1 and 2) show that "optimum growing conditions" as evidenced by the slope of the germination curves are provided by a constant temperature of 20°C. following suitable pre-treatment of the seed. This simply confirms Bientjes' results published in 1954, even for the unstratified seed, except that Bientjes did not use light during incubation.

The author states that "the method recommended by Allen and Bientjes rendered least total germination, i.e., a mean of 77.80 percent over the nine seed lots tested." It should be noted first, that the differences shown in Table 4 under 8 weeks' stratification are *not* significant, and secondly, that the author nowhere describes the stratification method used. Allen and Bientjes[2] showed that significant differences occur with various modifications of what is commonly called "stratification." It is desirable, even necessary, to detail the method if definite conclusions are to be drawn. In this laboratory the method is standardized and the temperature used is 0-1°C., not 5°C. as used by the author.

Under "Results and Discussion" the author states that "the germination response, however, did *appear* to be more prompt and uniform after stratification" (italics mine). Surely they *were* more prompt and surely this is a measure of approach to the "optimum" referred to in the title and introduction and in the conclusion.

The author argues for a particular method on the basis of "simplicity and rapidity which are the essence of seed testing." I am of the opinion that proximity to optimum conditions, and reproducibility come before "simplicity" and before "rapidity" as it is used by the author. Futhermore, it is doubtful that the claim of "simplicity" can really be substantiated. Stratification is not difficult in itself and, with modern techniques,[3] presents no problems. The use of 20° C. constant temperature without light poses no difficulties for the ordinary laboratory. The only serious argument is the extra time required for stratification and when total time is a consideration, stratification may have to be curtailed or eliminated.

Stratification shortens the incubation time with the attendant advantages of lessened difficulties from contamination and a saving in incubator space. This plus an increased rate of germination and greater uniformity as among lots is sufficient to recommend the method over the one proposed by the author.

For a more detailed discussion of the concept of "optimum" germination test procedures, the reader is referred to Allen and Bientjes' paper of 1954. Bientjes' paper gives a summarized account of a thorough statistical analysis of the effects of moisture content, stratification, and temperature, and their interactions.

GEORGE S. ALLEN
Dean, Faculty of Forestry,
University of British Columbia,
Vancouver

Further Comments

The paper by Dr. Te May Ching in the JOURNAL OF FORESTRY for April 1958 on germination conditions for western hemlock includes a number of statements and implications with which I differ.

Although one of the aims of standardizing test conditions is to secure maximum germination in the shortest possible time, Dr. Ching interprets her data in such a way that her "optimum condition" (dry sowing) actually requires 2 and 3 weeks longer for maximum germination than does the use of stratified seed. The crux of the problem appears to be the unusual inclusion of stratification time as part of the total germination period. I can find no official sanction for such addition of presowing treatment time to germination time, and I doubt if any nurseryman would schedule his operations on an unrealistic report showing 6 to 10 weeks for maximum germination of a lot of stratified seed.

As to Dr. Ching's interpretation of the effect of treatment and temperature on total germination, here again we lack a standard condition —that of the length of time during which the germination test is run. Frequently a test carried out one

[2]Bientjes, W. The effects of temperature, seed moisture, and stratification on the germination behavior of western hemlock seed. University of British Columbia Forest Club, Research Note No. 11. 7 pp. **1954.**

[3]Allen, G. S., and W. Bientjes. Studies on coniferous tree seed at the University of British Columbia. Forestry Chronicle 30: 183-196. **1954.**

week longer than another will give a significantly greater total germination. Conversely, if parallel tests are run long enough, even relatively inactive lots of seed may reach the same total germination as a vigorous lot.

To minimize the effect of varying duration of tests, I have recently developed a formula for evaluating any germination tests, purporting to be complete, in terms of a standard test period—which for certain practical considerations, has been arbitrarily set at 28 days. The formula evaluates a test by means of a single figure, the "germination value," in which the promptness and rapidity of germination, as well as total germination, receive due weight. The formula will be published after current tests to correlate field germination with germination values have been completed.

Applying this formula to data transcribed from Dr. Ching's curves in Figures 1 and 2, I find that, when only the time under germination conditions is considered, there is a very highly significant effect of treatment in favor of stratification. The *F* values were approximately three times those required for the 1 percent level. However, under optimum temperature conditions, the differences in germination values between 4 and 8 week stratification are not significant, and would not warrant the expense of refrigerating a lot of seed for an additional 4 weeks.

When checked by the formula, the effect of temperature during germination is highly significant. I agree with Dr. Ching that 20°C is optimum for western hemlock, and that even 8 weeks of stratification does not counteract the adverse effect of 15° germination temperature. The temperature range of 20-30° is equally unsuitable for best germination of dry seed, but its adverse effect is progressively minimized by increased periods of stratification. Finally, the specificity of germination temperatures for non-stratified seed, which Dr. Ching points out and which the formula confirms, is another powerful argument for stratifying western hemlock seed to secure the most prompt, rapid, and complete germination under a wide range of conditions.

FELIX J. CZABATOR
Southern Forest Expt. Sta.,
Forest Service,
U. S. Department of Agriculture

In Reply

The comments with reference to my recent publication, "Some Experiments on the Optimum Germination Conditions for Western Hemlock," are much appreciated. It appears that some of the objections to certain portions of the article are based upon a lack of clarification of terms and procedures used.

The critics of the article have assumed that there is opposition to the use of stratification in nursery establishment. No such statement was made or intended. Figures 2 and 3 show the effect of stratif-

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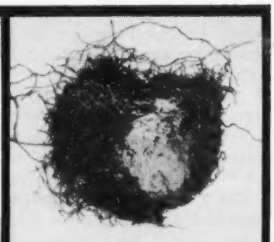

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ication, although this point was not included in the discussion. This was an oversight. The statement was also made that "the author nowhere describes the stratification method used." The stratification condition employed in the study was to place soaked or unsoaked seed on top of moist sand in a covered petri dish at 50° C as explained on page 278, column 2.

The crux of the problem, as pointed out by Dr. Czabator, is "the unusual inclusion of stratification time as part of the total germination period." It has been pointed out that the problem of the laboratory is to get a complete germination report as soon after the receipt of the sample as possible. This is a real problem in the Oregon laboratory which each year is receiving increasing quantities of tree seed for commercial test. For the seedsman who is awaiting the results of the germination test before consummating a sale it is of little consequence whether the elapsed time is spent in soaking the seed or stratifying it if the test itself is accurate. He is likely to consider the *total* time from the submission of the sample to the receipt of the completed test report as most important. As Dr. Allen has so aptly pointed out, "the only serious argument is the extra time required for stratification and when total time is a consideration, stratification may have to be curtailed or eliminated."

The paper in question presents data which indicates that stratification may be eliminated with no loss in accuracy of the test. The point is that some time may be saved in obtaining the final test, and that on many occasions this time is important. It is of little consequence whether stratification is considered as a part of the germination process or not, but it is necessary to recognize the total time involved in germination and pre-treatment. This paper simply points out a time saving possibility with no loss in accuracy.

TE MAY CHING
Assistant agronomist,
Oregon Agricultural
Experiment Station, Corvallis

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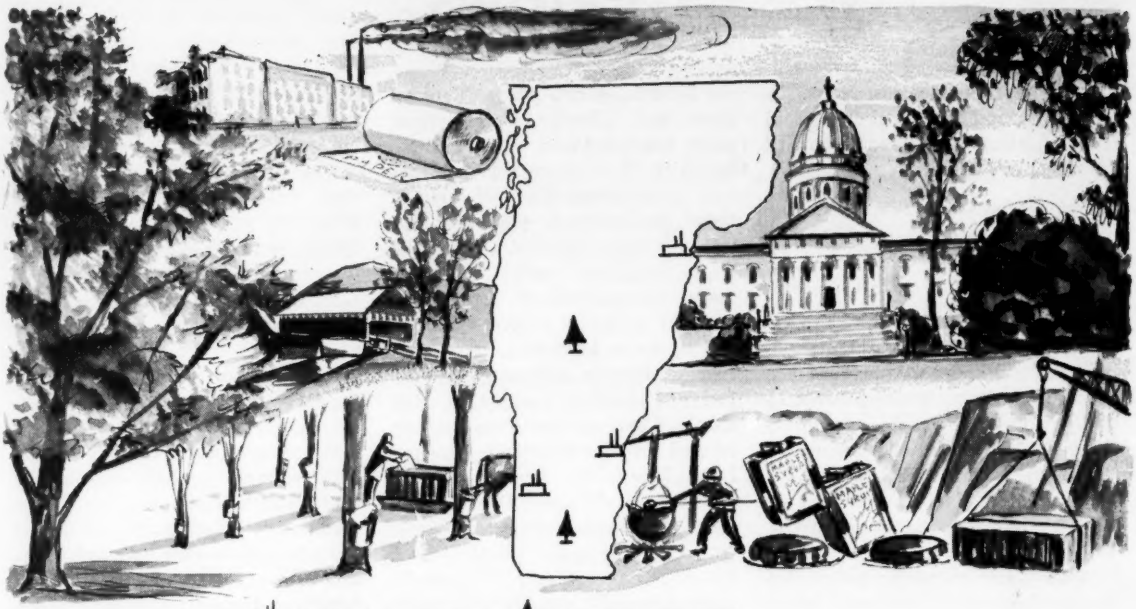

Vermont

The importance of the forests of Vermont may be inferred from the name of the state—Verde—mont—the Green Mountain State. Three hundred and fifty years after the discovery of Lake Champlain, the Green Mountains are still green. Of the State's 5,937,900 acres, 3,729,700 acres are in woodland. Ninety-two percent of this woodland is in the hands of 39,000 woodland owners.

492 sawmills, 77 other primary wood using industries and a host of industries manufacturing products from the size of golf tees to ships depend on this resource. An expanding year-around recreation industry, which accounts for a sizable part of the State's income, would be impossible without the forests. Vermont leads the nation in the production of maple syrup, one of its famous products.

The first settlers found the entire state forested and one of their first tasks was the clearing of land for agriculture. It is said that many paid for their farms with the ashes of the trees sold for potash.

For many years most cutting was done without consideration for the next timber crop. Most woodlands grew in a wild state without cultural measures. However, this trend has reversed itself in recent years, and more and more owners recognize the value of managing their timber to increase growth and improve quality.

As in other forested areas, large fires were not uncommon as late as 1910. This situation has improved to the point that Vermont now has one of the best fire records in the nation. It is estimated that insects and diseases destroy more timber than fire.

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Reviews

The Tree Identification Book. A New Method for the Practical Identification and Recognition of Trees

By George W. D. Symonds. Photographs by Stephen V. Chelminski. 268 pp. Lithoprinted, Illus. M. Barrows & Co., New York. 1958. $10.

Mr. Symonds has attempted, with a minimum of text and a maximum of photography (over 1,500 prints), to enable anyone to identify 119 species of common native and 17 exotic or naturalized trees of the Northeastern States. The author is a landscape architect.

There are chapters titled Acknowledgements, Contents, Introduction, Instructions, Appendix (with Bibliography), Glossary, and Index, all unpaged. The bulk of the book is in two parts, Pictorial Keys and Master Pages, these parts black-indexed on the edges, to which it is suggested that tabs may be attached. Each division of these two parts is paged on the "tabs." Many but not all of these pages contain a scale. "Pictorial Keys" are divided into seven groups: Opposite Leaves (including opposite branching), Thorns; Leaves (Simple, Odd-shaped, Very Large, Palmately Compound, Pinnately Compound); Flowers (arranged in chronological sequence from March to August); Fruit (Nuts, Pods, Winged, Berries, Odd and Miscellaneous); Twigs and Buds; Bark; and Needle-leaved Trees (*i.e.*, conifers). "Part II. Master Pages," covering 129 pages, contains habit pictures of the whole tree; some brief range, height and other notes; and places together the leaf, twig, flower, fruit, and bark pictures of the various species.

The pictures are good, in some cases excellent, especially considering the method of reproduction which, in the case of small delicate flowers (such as those of ash) results in a blurriness destructive of detail. Observation and cleverness often appear in the pictures and brief notes, for example, in showing the divergent buds of beech as contrasted with the appressed buds of shadbush; though, in the case of the former, one might wish that the picture showed the characteristic oblique position of the bud with reference to the leaf-scar and that the magnolia and sweetbay pictures indicated clearly (or mentioned) the twig-encircling stipule-scars. Common pathological conditions that might be

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mistaken for fruits are not forgotten, such as cedar-apple galls on redcedar and the staminate flower-galls of white ash. Perhaps especially noteworthy are the bark pictures and those differentiating the two catalpa species. The professional botanist would probably object to the listing of shadbush fruit as "berries." Instead of "red oak" a distinction between northern and southern red oaks would be desirable.

The author checked his scientific nomenclature with Rehder's Manual but mentions no standard for his common names. The Forest Service Check List would have made a good reference for this purpose. The reviewer regrets that the author did not follow the *principles* of name-compounding adopted by Standardized Plant Names and in the Check List; at least such inconsistencies would have been avoided as spelling Osage Orange, Sweet Bay, and Tulip Tree as two words, as contrasted with Ironwood, Nannyberry, and Yellowwood solid. The acceptance of Swamp Locust as the common name of *Gleditsia aquatica* is unfortunate. The proof-reading has been carefully done; I have detected only two small errors, the misspelling of Liberty Hyde Bailey's surname in the bibliography and that of *Taxus baccata* in the index. The paper birch design of the handsome (always ephemeral) jacket one might wish could have been preserved on the more permanent cover. It is unfortunate that a useful book such as this should be so expensive, the price putting it beyond the purse of many people who otherwise would wish to get copies.

WILLIAM A. DAYTON
Arlington, Virginia

Nature Is Your Guide

By Harold Gatty. 287 pp. Illus. E. P. Dutton, New York. 1958. $4.95.

Any book primarily concerned with the arts of recognizing locations and directions is bound to meet prejudice. Every writing of consequence on camping and woodcraft includes one or more chapters on pathfinding. And in wilderness living and survival, little advantage derives from discovering where one is if he doesn't know what to do when there. Fortunately this book reveals its own rich reasons for publication.

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Gatty's formal education centered at the Royal Australian Naval College. He was successively a ship's officer in the merchant marine, navigator for Wiley Post on their 1931 record-setting flight around the world, in charge of Air Navigation Research and Training for the U. S. Army Air Corps (between the wars) and, during World War II, Group Captain in the Royal Australian Air Force and Director of Air Transport for the Allied Air Forces in Java and at General MacArthur's headquarters in Australia and New Guinea. He has sailed, flown, and traveled over most of the world, and has lived in many parts of it.

Most men gifted with Gatty's skill with instrumental navigation scorn ancient arts of primitive navigators and ignore the many

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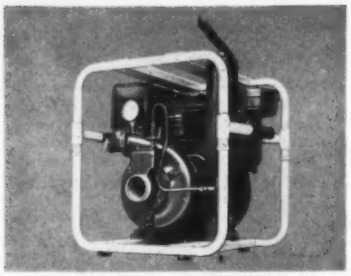

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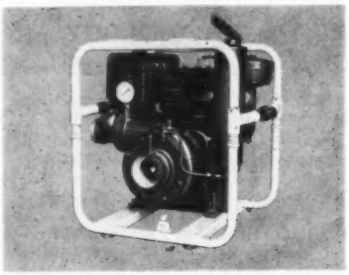

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. Foresters who enjoy ecological manifestations of lands they traverse will find this book interesting and rewarding. We who dwell amid semi-arid contrasts, miss certain critical phenomena until we note in the preface: ". . . no one book could . . . hope to cover every locality in detail . . . but illustrate(s) the type of thing which every reader can learn about his own locality."

The book is an excellent primer for increasing numbers of people who travel to all parts of the world. It is one of world travel—not to cities and other congested human phenomena, and not by ship or plane—but by intellect to lands and waters they populate.

J. V. K. WAGAR
Colorado State University

Experiences with the Weather

By William M. Bergman III. 371 pp. Vantage Press, New York. 1957. $3.50.

Weather is an age old topic and one of universal interest and importance.

An amateur weather enthusiast recounts in *Experiences with the Weather* 26 years of weather events in various localities in the Middle Atlantic States and New England. The author, a horticulturist by profession, describes in considerable detail the weather and its effects on plants, trees, insects, animals, and people. He is one of many who are charmed by nature in her many moods — by the miracle of the awakening earth in spring; by the spectacle of the painted forest in the fall; and by the unusual, sudden, and severe turns of the weather. But by the time these events have been similarly described for every occurrence in 26 years, the reading becomes exceedingly dull—even to the reviewer, who also kept a diary of weather events for several years.

Although voluminous data such as daily temperatures, precipitation amounts, timing of thunderstorms, and deviations from monthly normals are included, it is frequently impossible to tell where the observations were made or by whom. The author moves over several states during the period covered in the book, and his personal observations along the way are apparently mixed in with official Weather Bureau records and newspaper accounts. Consequently, the book is not adequate as a reference on the weather in any particular locality, though the area around Chesapeake Bay receives greatest attention.

Much of the book is devoted to routine data that might better have been summarized in tabular form and placed in an appendix. This would have left for the narrative only those events that were sufficiently unusual that to have lived through them might honestly have been classed as an "experience." Unusual events described by the author include an account of a tornado in Wilmington; a thundersquall that t u r n e d the writer around, bicycle and all; the strange overcast from Canadian forest fires in September 1950; hurricane Hazel as it roared across the Alfred I. Dupont Estate near Wilmington; and occasional encounters with thunderstorms, snowstorms, and cold fronts.

Weather affects everyone, and in pointing this out, the author gives special attention to the fishermen and yachtsmen on Chesapeake Bay; to the truck gardeners whose crops suffer annually from drought or frost; to the "autoist" each time it snows or becomes icy; to the office workers, factory workers, and vacationists during every hot spell; and to the school children in all weather.

The book follows a rather unusual style in that it is primarily a chronological account of weather data mixed with related and seemingly unrelated events. Within a few sentences in the same paragraph the author mentions a local maximum temperature, the minimum temperature at Oxford, Md., the next morning, a fall from his bicycle and the "disillusioned and disappointed Victory gardeners." Paragraphing is used only to separate monthly accounts, even though the weather in some months requires 4 pages to describe. Events in recent years are described in greater detail than those of earlier years. Starting with a half-page description of 1930, "The year of the great drought; a mild winter," the material presented for each year increases rapidly. For 1955 alone, a half-page title is followed by 21 pages of detailed accounts of day-to-day weather.

The forester will likely find little of interest in this book because the climatological data are available in more usable form elsewhere. The few accounts of unusual weather events are too far separated by unimportant detail to hold reader attention.

OWEN P. CRAMER
Pacific Northwest Forest and Range Experiment Station

Forest Fertilization

Compiled by Donald P. White and Albert L. Leaf. 305 pp. State University College of Forestry at Syracuse University, Syracuse, N.Y. 1956. No price indicated.

In recent years the advances in forest management intensity have increased the interest in site improvement through the addition of soil amendments. In compiling this worldwide coverage of the forest fertilization literature, the authors have performed a real service for foresters and others interested in this field. Here for the first time, is brought together the pertinent forest tree nutrition information as related to young stands, plantations, and nursery practices. Certain research investigations on shade tree fertilization along with greenhouse pot culture and hydroponic studies have been included. The 700 references include over 400 from foreign literature with translated titles, 317 of which are abstracted in some detail to facilitate an evaluation of the problem and results.

The authors recognized that a complete indexing would have been helpful; however, because of the complexity of the subject matter, only 200 of the major references were indexed to provide the reader a guide to 12 general categories. Foresters and investigators in the field of forest nutrition owe a vote of thanks to Drs. White and Leaf for their useful contribution which will save many hours of library research.

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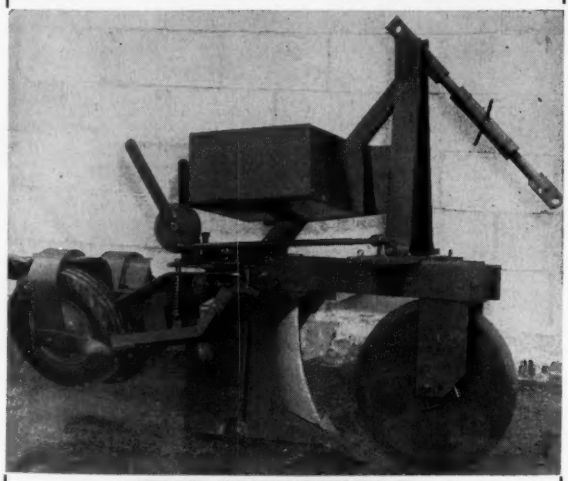

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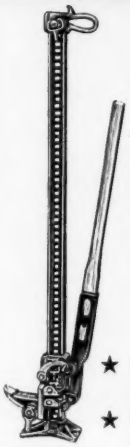

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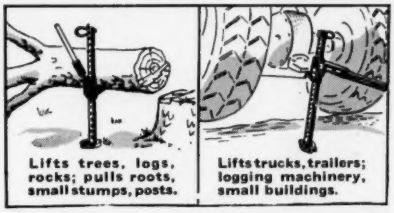

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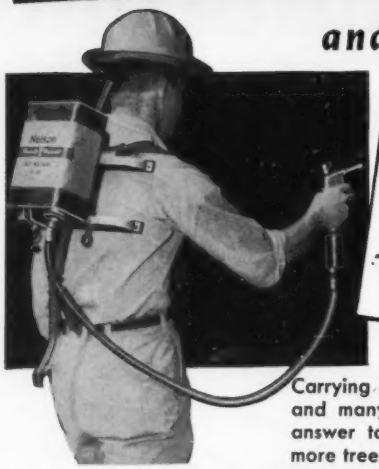

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Publications of Interest

Variation in Tracheid Length and Wood Density in Geographic Races of Scotch Pine by Robert M. Echols analyzes certain factors of wood quality for 15 European provinces, for trees grown on the Fox State Forest, Hillsboro, N. H. Very highly significant variations were found in tracheid lengths and wood density in the Scotch pine races examined. The results are given in Yale University School of Forestry Bulletin 64.

• • •

Foresters concerned with developing yield tables for managed stands (main stand plus thinnings) will find *Provisional Yield Tables for Oak and Beech in Great Britain* by W. T. Waters and J. M. Christie of interest. This 31-page booklet issued by the Forestry Commission sells for 2s. 6d. net. The publication includes various comparisons from yield tables prepared in Denmark and Germany with the British figures.

• • •

An agricultural dictionary *Maatalouden Sanakirja,* published by Kustannusosakeyhtio Otavan Kirjapaino, Helsinki, 1958, contains many terms dealing with forestry. Compiled under the auspices of the Scientific Agricultural Society of Finland by Liisa Mali, this book covers terms in Finnish with their Swedish, German and English equivalents. An introductory section of 28 pages is followed by 596 pages of terms, then an index of 177 pages.

• • •

Forest Fortune — An Industrial Prospect in Central West Virginia, published by the West Virginia Bankers Association, a 24-page, attractively illustrated, brochure points out the possibilities of the timber resources in a 12-county area. Copies may be obtained by writing the Conservation Commission, Division of Forestry, State Office Building No. 3, Charleston, West Virginia.

• • •

On the fiftieth anniversary of the Ohio Agricultural Experiment Station, J. F. Aughanbaugh, H. R. Muckley, and O. D. Diller have compiled *Performance Records of Woody Plants in the Secrest Arboretum.* In the 90-page booklet, Departmental Series 41, is recorded the year planted, the location, and the present status (or when failed and why) for more than 1,000 species from Abella to Zelkova.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University College of Forestry at Syracuse University*

Range Management Section Compiled by NELLIE G. LARSON, *Library, U. S. Department of Agriculture*

General

The Book of Trees. By W. C. Grimm. 363 pp. Illus. The Stackpole Co., Harrisburg, Pa. 1957. $5.00.

Flowering Trees of India. By M. S. Randhawa. 210 pp. Illus. Indian Council of Agric. Research, New Delhi. 1957. $7.50.

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Growing Red Cedar in Florida. By L. T. Nieland and A. S. Jensen. 7 pp. Illus. Florida Agric. Ext. Serv., Gainesville. 1958. Cir. No. 183.

Forest Management

Volume Determination for Second-Growth Slash and Longleaf Pine in Northeast Florida. By R. W. Cooper and D. F. Olson, Jr. 11 pp. Southeastern Forest Expt. Sta., Asheville, N. C. 1958. Sta. Paper No. 92. Mimeog.

Logging and Milling

Transportation and Handling of Whole Trees. By E. W. Fobes. 2 pp. U. S. Forest Products Lab., Madison, Wis. 1958. Rept. No. 1637-57. Mimeog.

Pathology

Control of Decay and Sap Stain in Logs and Green Lumber. By T. C. Scheffer. 13 pp. Illus. U. S. Forest Products Lab., Madison, Wis. 1958. Rept. No. 2107. Mimeog.

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California Flatheaded Borer. By R. L. Lyon. 7 pp. Illus. U. S. Forest Serv., Washington 25, D. C. 1958. For. Pest Leaflet No. 24. 5 cents (Govt. Print. Off.)

Forest Insect Conditions in the Southeast During 1957. By W. F. McCambridge, W. P. Nagel, and R. J. Kowal. 10 pp. Southeastern Forest Expt. Sta., Asheville, N. C. 1958. Sta. Paper No. 93. Mimeog.

Lodgepole Needle Miner. By G. R. Struble. 7 pp. Illus. U. S. Forest Serv., Washington 25, D. C. 1958. For. Pest Leaflet No. 22. 5 cents (Govt. Print. Off.).

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Checklist of Plants of the San Joaquin Experimental Range. By R. F. Buttery and L. R. Green. 32 pp. California Forest & Range Expt. Sta., Berkeley. 1958. Misc. Paper No. 23.

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Germination of Thiourea-Treated Bitterbrush Seed in the Field. By R. L. Hubbard and B. O. Pearson. 6 pp. California Forest & Range Expt. Sta., Berkeley. 1958. Forest Res. Notes No. 138.

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Mountain Farm Woodland Grazing Doesn't Pay. By E. R. Sluder. 2 pp.

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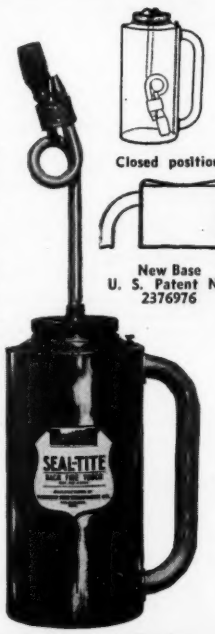

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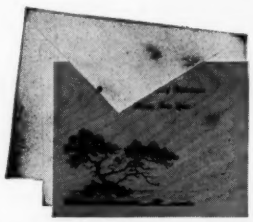

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The Occurrence of Spruce in the Interior of British Columbia. By E. H. Garman. 31 pp. Illus. B. C. Forest Serv., Victoria. 1957. Tech. Publ. No. 49. 50 cents.

Silvicultural Characteristics of American Basswood. By H. F. Scholz. 15 pp. Illus. Lake States Forest Expt. Sta., St. Paul, Minn. 1958. Sta. Paper No. 62. Mimeog.

Silvicultural Characteristics of Bigtooth Aspen. By P. E. Slabaugh. 16 pp. Lake States Forest Expt. Sta., St. Paul, Minn. 1958. Sta. Paper No. 63. Mimeog.

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Bin Pallets for Agricultural Products. By T. B. Heebink. 10 pp. Illus. U. S. Forest Products Lab., Madison, Wis. 1958. Rept. No. 2115. Mimeog.

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Hough's Encyclopedia of American Woods. Vol. 2. By E. S. Harrar. 2 sections. 75 wood samples. Robert Speller, New York. 1958. $25.

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Plan Special Issue for November

Plans are well underway to devote the November 1958 issue of the JOURNAL OF FORESTRY to the subjects of forest genetics and forest tree improvement.

Society Affairs

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Coming Events

CIF to Hold 50th Anniversary Meeting

The Canadian Institute of Forestry will hold its 50th Anniversary annual meeting October 7-9, 1958, at Fredricton, New Brunswick.

Soil Conservation Society

City Auditorium, Asheville, N. C. will be headquarters for the 13th annual meeting of the Soil Conservation Society October 19-22.

American Forestry Association

The 83rd annual meeting of the American Forestry Association will be held in Tucson, Ariz., October 27-30, 1958. Headquarters will be the Pioneer Hotel. Meeting theme: "Water, Forests, and People."

Southeastern Section

The Southeastern Section has scheduled its winter meeting for January 22-23, 1959 at Mongomery, Ala.

Kentucky-Tennessee Section

Mammoth Cave, Ky., will be the scene of the winter meeting of the Kentucky-Tennessee Section January 30-31, 1959.

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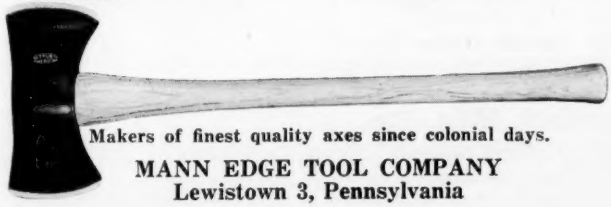

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Council's Column

A Chapter's Vote on Registration

On June 12, 1958 the Georgia Chapter of the Southeastern Section endorsed, without one dissenting vote, a proposal to require the registration of any foresters who practices forestry on lands of another, i.e., lands not his own or belonging to his immediate employer. This at first look might seem a rather radical step, but it is just as inevitable as night following day. It is indeed a significant movement, for today only Georgia, Alabama, and Michigan have permissive registration provided for by state statute. But Georgia, with nearly 500 foresters, and nearly eight years of registration experience has realized that something more than just a permissive enabling act for registration is necessary.

It is even more significant when we realize that this movement marks the first time that legally the practice of the profession of forestry and those qualified to engage in the profession will be fully recognized by one of the sovereign states and enforced by legal statute. This, of course, will be contingent on the forthcoming general assembly passing the required legislation.

The proposed legislative statute vests in the Board of Registration the power to recognize the quality of the various schools of instruction, plus the qualifications of the applicant for registration, at the same time denying the right to practice forestry to those who are by law unqualified. Corollary will be punishment by fines for infractions of the rules covering the practice of forestry on lands of another by unqualified (unregistered) persons. The proposed statutes states at the outset: "It is the purpose of this Act to protect the public by improving the standards relative to the practice of professional forestry."

Just think what this means. In recent years, many Chapter, Section, and national meetings have been replete with complaints that unqualified, poorly educated and sub-standard persons were dispensing forest management advice to the general public based on some arithmetical juxtaposition of a mathematical formula. Said formula was topped off with copious doses of what might appear practical advice which could be professionally challenged. Compulsory registration could easily bring to an end such allegedly nefarious practices.

Coincidental with complaints of the dispensation of inferior forestry advice have been warnings that many schools were offering curricula, leading to a degree in forestry which were professionally sub-standard and could not be accredited by the Society of American Foresters. There is no law, nor will there be, prohibiting forestry schools. But compulsory registration, whereby the Board of Registration reserves unto itself the right to approve the forestry school and the graduates of the school, which requirement by its very nature must encompass the basic quality of the courses offered, presents an automatic control. The proposed Georgia law also provides for a written examination administered by the board designed to show knowledge and skill approximating that obtained by graduation from a board-approved school; the examination being given to graduates of schools not approved by the board. No longer can the professional standards of work quality, pay grades, and general acceptance of foresters by the public be short-circuited. If the graduate cannot be registered as a qualified professional forester, he becomes extremely limited as to his professional endeavors on lands of the general public.

It should not be construed that compulsory registration of foresters as contemplated offers a panacea for all the ailments of the profession. There will always be the necessity for a code of ethics and a need for straight-thinking, hardworking personnel imbued with the philosophy of service above self. Men with a sense of high professional standards will always be in demand.

However, even the most naive will have to admit that compulsory registration, backed by the legislative and enforcement powers of a sovereign state, will go quite a way in protecting the hard won gains of one of America's most honored professions.

B. E. ALLEN

Southern California Section Has New Officers

Two new officers of the Southern California Section have begun their duties. They are chairman, Lynn R. Biddison, Fontana, Calif., and secretary, Robert Blanford, of Riverside, Calif.

The office of vice president will be filled at a later date.

Colleges and Universities in the United States Offering Instruction in Forestry (October 1, 1958)

Accredited

The following institutions are accredited for forestry instruction by the Council of the Society of American Foresters.

Alabama Polytechnic Institute, Department of Forestry, Auburn, Ala.

University of California, School of Forestry, Berkeley 4, Calif.

Colorado State University, College of Forestry and Range Management, Fort Collins, Colo.

Duke University, School of Forestry, Durham, N. C.

University of Florida, School of Forestry, Gainesville, Fla.

University of Georgia, School of Forestry, Athens, Ga.

University of Idaho, College of Forestry, Moscow, Idaho.

Iowa State College, Department of Forestry, Ames, Iowa.

Louisiana Polytechnic Institute, Department of Forestry, Ruston, La.

Louisiana State University, School of Forestry, Baton Rouge 3, La.

University of Maine, School of Forestry, Orono, Maine.

University of Massachusetts, Department of Forestry and Wildlife Management, Amherst, Mass.

Michigan College of Mining and Technology, Department of Forestry, Houghton, Mich.

Michigan State University, Department of Forestry, East Lansing, Mich.

University of Michigan, School of Natural Resources, Ann Arbor, Mich.

University of Minnesota, School of Forestry, St. Paul 1, Minn.

University of Missouri, School of Forestry, Columbia, Mo.

Montana State University, School of Forestry, Missoula, Mont.

State University of New York, College of Forestry, Syracuse 10, N. Y.

North Carolina State College, School of Forestry, Raleigh, N. C.

Oregon State College, School of Forestry, Corvallis, Ore.

Pennsylvania State University, School of Forestry, University Park, Pa.

Purdue University, Department of Forestry and Conservation, Lafayette, Ind.

Utah State University, College of Forestry, Range and Wildlife Management, Logan, Utah.

University of Washington, College of Forestry, Seattle 5, Wash.

West Virginia University, Division of Forestry, Morgantown, W. Va.

Yale University, School of Forestry, New Haven 11, Conn.

Not Accredited

The following institutions offer professional and/or technical curricula in forestry, but do not meet the requirements for accreditation.

Arkansas Agricultural and Mechanical College, Department of Forestry, College Heights, Ark.

Stephen F. Austin State College, Department of Forestry, Nacogdoches, Texas.

Clemson Agricultural College, Forestry Department, Clemson, S. C.

University of Connecticut, Department of Forestry and Wildlife Management, Storrs, Conn.

Harvard University, Harvard Forest, Petersham, Mass.

McNeese State College, Department of Plant Science, Lake Charles, La.

Mississippi State College, Department of Forestry, State College, Miss.

University of Illinois, Department of Forestry, Urbana, Ill.

University of New Hampshire, Department of Forestry, Durham, N. H.

Oklahoma State University of Agriculture and Applied Science, Department of Forestry, Stillwater, Okla.

University of the South, Forestry Department, Sewanee, Tenn.

Southern Illinois University, Department of Forestry, Carbondale, Ill.

Virginia Polytechnic Institute, Department of Biology, Blacksburg, Va.

State College of Washington, Department of Forestry and Range Management, Pullman, Wash.

Introductory, Preforestry, and Specialized Courses

Abraham Baldwin Agricultural College, Tifton, Ga.

University of Arkansas, Department of Horticulture, Fayetteville, Ark.

Centenary College of Louisiana, Department of Biology, Shreveport, La.

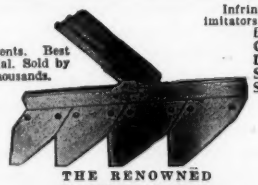
Cornell University, Department of Conservation, Ithaca, N. Y.

Grand Rapids Junior College, Grand Rapids, Mich.

Humboldt State College, Forestry Department, Arcata, Calif.

Idaho State College, Pocatello, Idaho.

University of Kentucky, Department of Horticulture, Lexington, Ky.



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University of Maryland, Department of Horticulture, College Park, Md.

Nichols Junior College, Duddley, Mass.

North Dakota Agricultural College, Department of Horticulture and Forestry, Fargo, N. Dak.

North Dakota School of Forestry, Bottineau, N. Dak.

Northwestern State College, Agriculture Department, Natchitoches, La.

Ohio State University, Department of Horticulture and Forestry, Columbus 10, Ohio.

Paul Smith's College, Forestry Department, Paul Smiths, N. Y.

Pasadena City College, Pasadena 4, Calif.

University of Rhode Island, Forestry Department, Kingston, R. I.

Rutgers University, Department of Forestry, New Brunswick, N. J.

University of Tennessee, Department of Horticulture and Forestry, Knoxville 16, Tenn.

Texas A & M College, Department of Range and Forestry, College Station, Texas.

University of Vermont, College of Agriculture, Burlington, Vt.

Wisconsin State College, Botany Department, Superior, Wis.

University of Wisconsin, College of Agriculture, Madison, Wis.

Ranger Schools

State Forest Ranger School of the University of Florida, Lake City, Fla.

State Ranger School of State University College of Forestry, Wanakena N. Y.

Special Watershed Program Featured at AAAS Meeting

Announcement has been made that the American Association for the Advancement of Science will hold its annual meeting in Washington December 26-31. Foresters will be interested in many of the programs covering the principal fields of science but especially Section O (Agriculture) which under the title "Water and Agriculture" will conduct a symposium on the subject and in addition feature many other papers given in the program below.

MONDAY MORNING, DEC. 29

9:00 a.m.; South Ballroom, Hotel Willard; Symposium: Water and Agriculture, Part I: Water for the Future.

D. A. Williams, Soil Conservation Service, USDA, *Presiding.*

1. Water Resources Planning and Development in Agriculture. Edward A. Ackerman, Resources for the Future, Washington, D. C. (Lantern, 30 min.)

2. Legal Aspects of Water Use in Agriculture. Clarence A. Davis, Attorney, Washington, D. C. (30 min.)

3. Significance of Small Watershed Programs to American Agriculture. Carl B. Brown, Soil Conservation Service, Washington, D. C. (30 min.)

4. Impact of Water Management and Agriculture on Ground-Water Supplies. R. L. Nace, U. S. Geological Survey, Washington, D. C. (Lantern, 30 min.)

5. Discussion Leader. Bernard Frank, Forest Service, USDA, Washington, D. C. (30 min.)

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MONDAY AFTERNOON, DEC. 29

2:00 p.m.; South Ballroom, Hotel Willard; Symposium: Water and Agriculture, Part II: Water Sources.

H. J. Sloan, University of Minnesota, *Presiding.*

1. Factors that Affect the Water Cycle. William C. Ackerman, Illinois State Water Survey Division, Urbana, Illinois. (30 min.)

2. The Effects of Weather Modification on Water Supplies. Howard T. Orville, Beckman and Whitley, Inc., Long Green, Maryland. (Lantern, 30 min.)

3. Use of Climatic Data on Guiding Farming Operations. C. H. M. Van Bavel, Agricultural Research Service, Raleigh, North Carolina. (Lantern, 30 min.)

4. Precipitation Measuring and Analyses as an Aid to Agriculture. G. L. Barger, U. S. Weather Bureau, Asheville, North Carolina. (30 min.)

5. Discussion Leader. Vincent J. Schaefer, Director of Research, The Munitalp Foundation, Inc., Schenectady, New York. (30 min.)

MONDAY EVENING, DEC. 29

8:00 p.m.; Executive Room, Willard Hotel. AAAS Section O—Agriculture Business Meeting.

TUESDAY MORNING, DEC. 30

9:00 a.m.; South Ballroom, Hotel Willard; Symposium: Water and Agriculture, Part III: Water Planning and Use.

Roy L. Lovvorn, North Carolina Agricultural Experiment Station, *Presiding.*

1. Relations between Soil Conservation Practices and the Availiability of Water for Agriculture. Cecil H. Wadleigh, Agricultural Research Service, USDA, Beltsville, Maryland. (Lantern, 30 min.)

2. Increasing Water Yields by Forest Management. Herbert C. Storey, Forest Service, USDA, Washington, D. C. (30 min.)

3. Interdependence of Upstream and Downstream Water Management. Wayne D. Criddle, Utah State Engineer, Salt Lake City, Utah. (Lantern, 30 min.)

4. Views of Water Users in Federal Reclamation Projects. William I. Palmer, Bureau of Reclamation, Washington, D. C. (30 min.)

5. Discussion Leader. William G. McGinnies, Central States Forest Experiment Station, Columbus, Ohio. (30 min.)

TUESDAY AFTERNOON, DEC. 30

2:00 pm.; South Ballroom, Hotel Willard; Symposium: Water and Agriculture. Part IV: Water Control.

Louis M. Thompson, Iowa State College, *Presiding.*

1. Drainage Problems on Agricultural Lands. T. W. Edminster, Agricultural Research Service, USDA. Beltsville, Maryland. (Lantern, 30 min.)

2. Control of Aquatic Vegetation and Phreatophytes. F. L. Timmons. Agricultural Research Service, USDA, Laramie, Wyoming. (30 min.)

3. Suppressing Evaporation from Water Surfaces. G. Earl Harbeck, Jr., U. S. Geological Survey, Denver, Colorado. (30 min.)

4. Energy Balance Approach to Evapotranspiration from Crops. C. B. Tanner, University of Wisconsin, Madison, Wisconsin. (30 min.)

5. Discussion Leader. Waldo E. Smith, American Geophysical Union, Washington, D. C. (30 min.)

6. Presentation of the AAAS-Campbell Award for Vegetable Research by Louis P. Reitz.

Northern Rocky Mountain Section Has Successful Year

During the past year the Northern Rocky Mountain Section held seven successful meetings at approximately monthly intervals, according to a report by Chairman Victor O. Sandberg. The meetings were varied in character from technical discussions of watershed management and fire control to a special ladies night with musical entertainment and an illustrated talk on atomic hazards and forestry. A spring field trip concluded the meetings. In one meeting serious consideration was given to the possibility of reorganizing the Section on a Chapter basis in order to increase membership in the widespread area covered by the Section.

As an example of what went on at one meeting (January 15, 1958), the following is quoted from Chairman Sandberg's report:

"This meeting was held at the Aerial Fire Depot just out of Missoula in conjunction with the Forest Service Junior Professional Orientation Meeting. About 100 Forest Service employees were in attendance, plus 60 members of the Society. Dinner was served in the cafeteria, followed by an enlightening talk by Associate Justice 'Wes' Castles of the State of Montana on current legislation in Forestry and the place of the State Supreme Court in Forestry and conservation in legislative matters. Justice Castles is a graduate of both Law and Forestry from Montana State University, so his comments on legislative needs in Forestry was of particular interest to the group. In addition to this part of the program the Forest Service Trainees presented an interesting program of skits and music."

Deadline for Consultants Listing

Consulting foresters who wish to have their names included in the Directory of Consulting Foresters, to be published in the January 1959 JOURNAL OF FORESTRY, should apply to the Society office not later than November 1, 1958. Information supplied should follow the form used in the directory published in the Janu-

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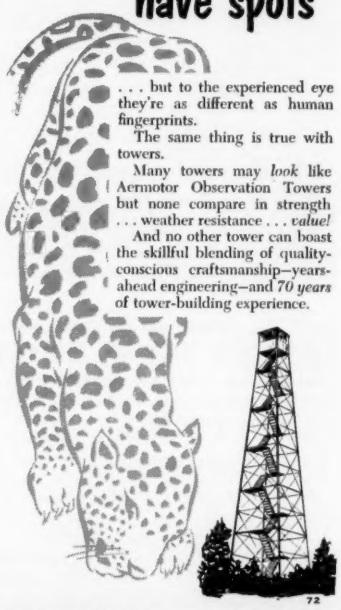

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ary 1958 JOURNAL. Members to be listed must be in good standing, i.e., have paid 1958 Society dues.

Consultants whose listings appeared in the previous directory and who have not returned inquiry cards mailed in September should do so at once.

Membership Applications & Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of August are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of November 1958.

Communications from the voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Junior Grade

Francis, J. M., 707 Prospect Avenue, Bethlehem, Pa. (Reinstatement).
Hebert, O. G., asst. dist. forester, Bel Air, Md., Purdue, BSF 1958.

Students Eligible for Automatic Advancement

PENNSYLVANIA STATE UNIVERSITY

Loftus, N. S. Neumann, F. P.

WEST VIRGINIA UNIVERSITY

Goughnour, C. A. McManigle, M. L.
Lemaster, J. T. Yokum, O. K.

Appalachian Section

Junior Grade

Students Eligible for Automatic Advancement

DUKE UNIVERSITY

Ketcham, D. E. Post, B. W.

NORTH CAROLINA STATE COLLEGE

Smith, E. R.

Central States Section

Junior Grade

Wood, L. F., state nursery supt. Zanesville, Ohio (Affiliate 1953).

Students Eligible for Automatic Advancement

PURDUE UNIVERSITY

Brundage, R. S.

Affiliate Grade

Hershberger, R. E., tech., Ohio Agric. Expt. Station, Wooster, Ohio.

Columbia River Section

Junior Grade

Campbell, R. A., asst. forester, Rosboro Lbr. Co., Springfield, Ore.; Ore. State, BSF 1948.

Gulf States Section

Junior Grade

Donceel, G. T., dist. forester, Kirbyville, Tex. (Affiliate 1955).
Webb, C. E., forester, USFS, New Albany, Miss. (Reinstatement).

Students Eligible for Automatic Advancement

LOUISIANA POLYTECHNIC INSTITUTE

Murphy, J. W. Smith, W. T.
Powell, C. E. Zeagler, J. H.

LOUISIANA STATE UNIVERSITY

Linnartz, N. E. Miles, B. R.
Mareus, C. A. Smoke, T. D.

Member Grade

Lamkin, S. W., unit forester, International Paper Co., Nacogdoches, Tex.; LPI, BSF 1950 (Junior 1954).

Affiliate Grade

Graham, W. L., forestry aid, Southern Forest Experiment Sta., Oxford, Miss.
Meeks, H. L., mgmt. forester, Miss. Forestry Comm., P. O. Box 749, Brookhaven, Miss.

Inland Empire Section

Junior Grade

Young, K. I., dist. forester, St. Joe Nat'l. Forest, Avery, Idaho; Mont. State, BSF 1950.

Intermountain Section

Junior Grade

Coonrod, M. A., forester, USFS, Ogden, Utah. (Reinstatement).
Inman, L. L., asst. prof. of forestry, Univ. of Idaho, Moscow, Idaho. (Reinstatement).
Walker, A. W., asst. dist. forest ranger, Buffalo Ranger Sta., Island Park, Idaho. (Reinstatement).

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Wikstrom, J. H., forest economist, Intermountain Forest & Range Expt. Sta., USFS, Ogden, Utah; Utah State, BSF 1941.

Students Eligible for Automatic Advancement

UTAH STATE UNIVERSITY

Brock, D. D. Rushton, S. M.
Dolph, R. E. Scott, N. C.
Dutton, D. W. Scott, S. A.
Elliott, T. D. Stewart, J. B.
Murphy, J. L. Wolfe, M. L.

Affiliate Grade

Mickelson, H. L., staff asst. forester, Wasatch Nat'l. Forest, 465 Fed. Building, Salt Lake City, Utah.

New England Section

Student Grade

YALE UNIVERSITY

Daly, E. F.

New York Section

Junior Grade

Kerr, R., U. S. Army, A.P.O. 112, New York, N. Y. (Reinstatement).
Whittaker, B. J., U. S. Army, A.P.O. 175, New York, N. Y. (Reinstatement).

Northern California Section

Member Grade

Charter, W. G., USFS, forester, Eldorado

Nat'l. Forest, Placerville, Calif.; Univ. of Calif., BSF 1953. (Junior 1953).

Northern Rocky Mountain Section

Junior Grade

Students Eligible for Automatic Advancement

MONTANA STATE UNIVERSITY

Mutch, R. W.

Ozark Section

Junior Grade

Students Eligible for Automatic Advancement

UNIVERSITY OF MISSOURI

Hilgemann, W. O. Jourden, R. L.

Puget Sound Section

Affiliate Grade

Murphy, F. L., asst. dist. administrator, Dept. of Natural Resources, P. O. Box 570, Chehalis, Wash.

Southeastern Section

Student Grade

UNIVERSITY OF FLORIDA

Cochran, J. R. Moody, C. J.
Glenn, D. A. Nelson, B. W.
McKeithen, A. A. Snedaker, S. C.

UNIVERSITY OF GEORGIA

Helm, W. R. NeSmith, J. E.

Junior Grade

Roger, R. W., forester, Heflin, Ala.; N. C. State, BSF 1946.

Students Eligible for Automatic Advancement

ALABAMA POLYTECHNIC INSTITUTE

Carpenter, J. W.

UNIVERSITY OF FLORIDA

Corbett, R. L. Kohrt, R. K.
Swofford, L. J.

UNIVERSITY OF GEORGIA

Bethea, G. E. Johnson, W. L.
Harrison, D. L. Johnston, G. W.
James, J. C. Moore, W. E.
Wyckoff, H. L.

Member Grade

Armstrong, F. H., instructor, Capt. U. S. Army, Fort Benning, Ga.; W. Va. Univ., BSF 1949 (Junior 1950).

Becker, D. W., working circle forester, St. Regis Paper Co., Pensacola, Fla.; Univ. of Fla., BSF 1951 (Junior 1952).

Cote, A. J., asst. dist. forester, Ga. Forestry Comm., Rome, Ga.; Univ. of Ga., BSF 1953 (Junior 1953).

Affiliate Grade

Fuzzell, S. G., forester, W. E. Belcher Lbr. Co., Centerville, Ala.

Jacobs, A. L., asst. dist. forester, Ga. Forestry Comm., Box 96, McRae, Ga.

Upper Mississippi Valley Section

Student Grade

UNIVERSITY OF MINNESOTA

Nelson, A. L.

Junior Grade

Gorman, E. J., woodlands mgr., St. Regis Paper Co., Sartell, Minn. (Affiliate 1946).

Makela, H. J., administrative asst. ranger, Marcell, Minn. (Affiliate 1953).

Newville, D. F., self employed dealer, forest products, Ely, Minn.; Iowa State, BSF 1934.

Vail, C. F., forestry headquarters, Park Rapids, Minn.; Univ. of Minn., BSF 1946.

White, R. G., forester, Blandin Paper Co., Grand Rapids, Minn.; Univ. of Minn., BSF 1958

Students Eligible for Automatic Advancement

IOWA STATE COLLEGE

Williams, H. S.

UNIVERSITY OF MINNESOTA

Berndt, W. A. Haugen, E. F.
Hoelzel, F. W.

Wisconsin-Michigan Section

Student Grade

UNIVERSITY OF MICHIGAN

McCormick, R. J.

Junior Grade

Students Eligible for Automatic Advancement

MICHIGAN STATE UNIVERSITY

Gibbons, C. F. Miller, N. A.
Hawes, R. W. Rulison, J. G.
MacKinder, R. C. Straub, P. W.
Tarr, W. H.

UNIVERSITY OF MICHIGAN

Fahey, T. D. Lanham, D. A.
Harper, S. C. LeMaire, R. E.

Affiliate Grade

Henze, W. A., forester and consultant, Upper Mich. Prod. Co. lands, Iron Mountain, Mich.

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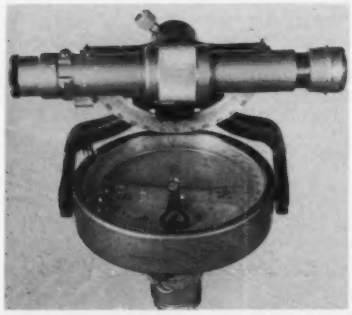

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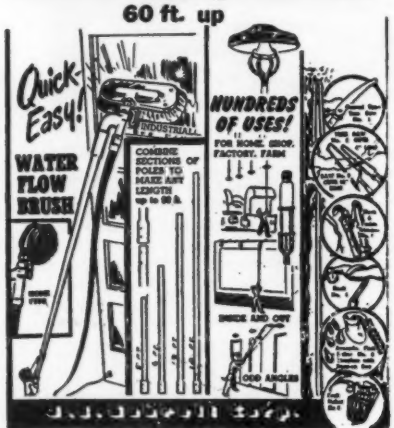

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Forestry News

NEW OFFICERS of the Council of Forestry Association Executives are shown above. They are from left to right: William Laybourne, Ohio Forestry Association, secretary; J. H. Kitchens, Jr., Louisiana Forestry Association, chairman; Ed Wagoner, Texas Forestry Association, vice chairman.

The Council held its tenth annual meeting July 29-August 1 in Groton, Mass. The history and work of the Massachusetts Forest and Park Association was described in detail to the visiting association representatives and problems common to state, regional, and national forestry organizations were discussed.

Congress Authorizes Study of Insecticides on Fish and Wildlife

An act authorizing and directing the Secretary of the Interior to undertake continuing studies of the effects of insecticides, herbicides, and fungicides on fish and wildlife has been passed by Congress. The act has for its purpose the prevention of losses of these natural resources following spraying and to provide basic data on various chemical controls so that forests, croplands, wetlands, rangelands and other lands can be sprayed with minimum losses to fish and wildlife.

Authorization is for an annual appropriation of $280,000. No money was appropriated with the act, but efforts are being made to obtain $125,000 through a supplemental appropriation to initiate the research.

Meetings Held to Study Small Woodlands

Ways to increase the country's timber supply for the years ahead are being explored in a series of meetings featuring the role of the small timber tract. Meetings are under joint sponsorship of the U.S. Forest Service and the states. Out of 16 meetings scheduled five remain to be held this fall as follows: October 14 — Rapid City, S. D.; October 21 — Lincoln, Nebraska; October 23—Manhattan, Kansas; November 3—Olympia, Washington, and November 6—Salem, Oregon.

Maine Marks Beginning of Fire Lookouts

Fifty-three years of progress in forest fire detection and prevention were marked July 26 when exercises commemorating the establishment of the Squaw Mountain forest fire lookout were held at Squaw Mountain Inn, Greenville Junction, Maine.

Co-sponsored by the Maine Committee of AFPI and the Maine Forestry District, the program marked the establishment of the oldest forest fire lookout in Maine and the first continuously operated lookout station in the nation. It was constructed and financed by the M. G. Shaw Lumber Co., then operating near Greenville.

The program included speeches by J. L. Madden, vice-president, Scott Paper Co.; Richard E. McArdle, chief, U. S. Forest Service, and A. D. Nutting, former forest commissioner and now head of the School of Forestry, University of Maine. Curtis M. Hutchins, chairman of the board, Dead River Co., was master of ceremonies.

Court Upholds Gypsy Moth Spraying

In a suit instituted by residents and property owners on Long Island to restrain the U.S. Department of Agriculture from spraying with DDT to control the gypsy moth Judge Walter Bruckhausen held that the plaintiffs failed to establish that the spraying was injurious to health.

In the decision, however, Judge Bruckhausen pointed out "It is evident that more intensive planning, preparation and caution should be exercised in connection with spraying a highly developed and built-up section such as Long Island than in the case of woodlands in the more isolated areas."

Moreover the judge held "that the mass spraying has a reasonable relation to the public objective of combatting the evil of the gypsy moth and thus is within the proper exercise of the police power of designated officials."

Copies of the decision may be obtained from the Plant Pest Division, U. S. Department of Agriculture, Washington, D. C.

Northeastern Forest Tree Improvement Conference Held in Maryland

Beltsville, Maryland, was the locale of the sixth annual meeting of the Northeastern Forest Tree Improvement conference. Chairmanned by E. L. Giddings, the two-day meeting (August 21-22) was attended by some 80 persons. Technical papers included: Vegetative propagation of forest trees by L. J. Enright, University of Maryland; Possibilities of using the Forest Survey to locate individual trees that are superior with respect to wood quality by Harold C. Mitchell, Forest Products Laboratory; Report on a seed origin study with loblolly pine, by Silas Little, Northeastern Forest Experiment Station; Techniques in breeding new varieties of orchard trees by J. W. McKay, Agricultural Research Service, Beltsville, Maryland; and Report on a cooperative seed origin study with Virginia pine by Craig D. Whitsell, Maryland Department of Research and Education.

Tours of the forest genetics plantations on the Beltsville Experimental Forest and of the Plant Industry Station to see plant breeding and related research provided opportunities to inspect the research programs in the area.

Officials elected for the new year are: chairman, H. C. Buckingham; vice chairman, A. D. Nutting; secretary-treasurer, E. J. Schreiner.

Klamath Forest Lands Bill Passed

President Dwight Eisenhower has signed the Klamath Termination Act amended by Congress to permit private or federal acquisition of Klamath Indian Reservation forest lands. Sale of land and timber to private concerns would be authorized if they agree to the sustained-yield management plans approved by the U. S. Departments of Interior and Agriculture. If private concerns do not buy the timberland by April 1, 1961, the federal government would purchase it for a national forest. The law also provides for acquisition of the 23,000-acre Klamath Marsh, a water-fowl area within the reservation, by the U. S. Fish and Wildlife Service for inclusion in the National Refuge system.

Public

Southern Forest Fire Laboratory Being Built

A forest fire research laboratory is being built near Macon, Georgia, and is scheduled to begin operating early in 1959, according to Joseph F. Pechanic, director of the Southeastern Forest Experiment Station.

The southern laboratory, a joint undertaking between the U. S. Forest Service and the State of Georgia will be located at the Georgia Forestry Center. For the construction of the facility, Georgia's Governor Marvin Griffin made funds available to the Georgia Forest Research Council. Equipping and staffing the laboratory will be possible through recently increased federal funds to step up forest fire research in the South.

R. L. Osborne Joins U. S. Tariff Commission Staff

Raymond L. Osborne, formerly with the American Wood Preservers Institute, Atlanta, Ga., recently joined the staff of the U.S. Tariff Commission's Lumber and Paper Division in Washington, D.C.

A forestry graduate in 1931 of the University of Minnesota, he was with the U. S. Forest Service prior to to World War II, during which he served as a naval lieutenant. He was forester for Kettle River Lumber Company of St. Louis, a subsidiary of American Creosoting Company until becoming southeastern representative for the Wood Preservers Institute.

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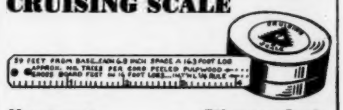
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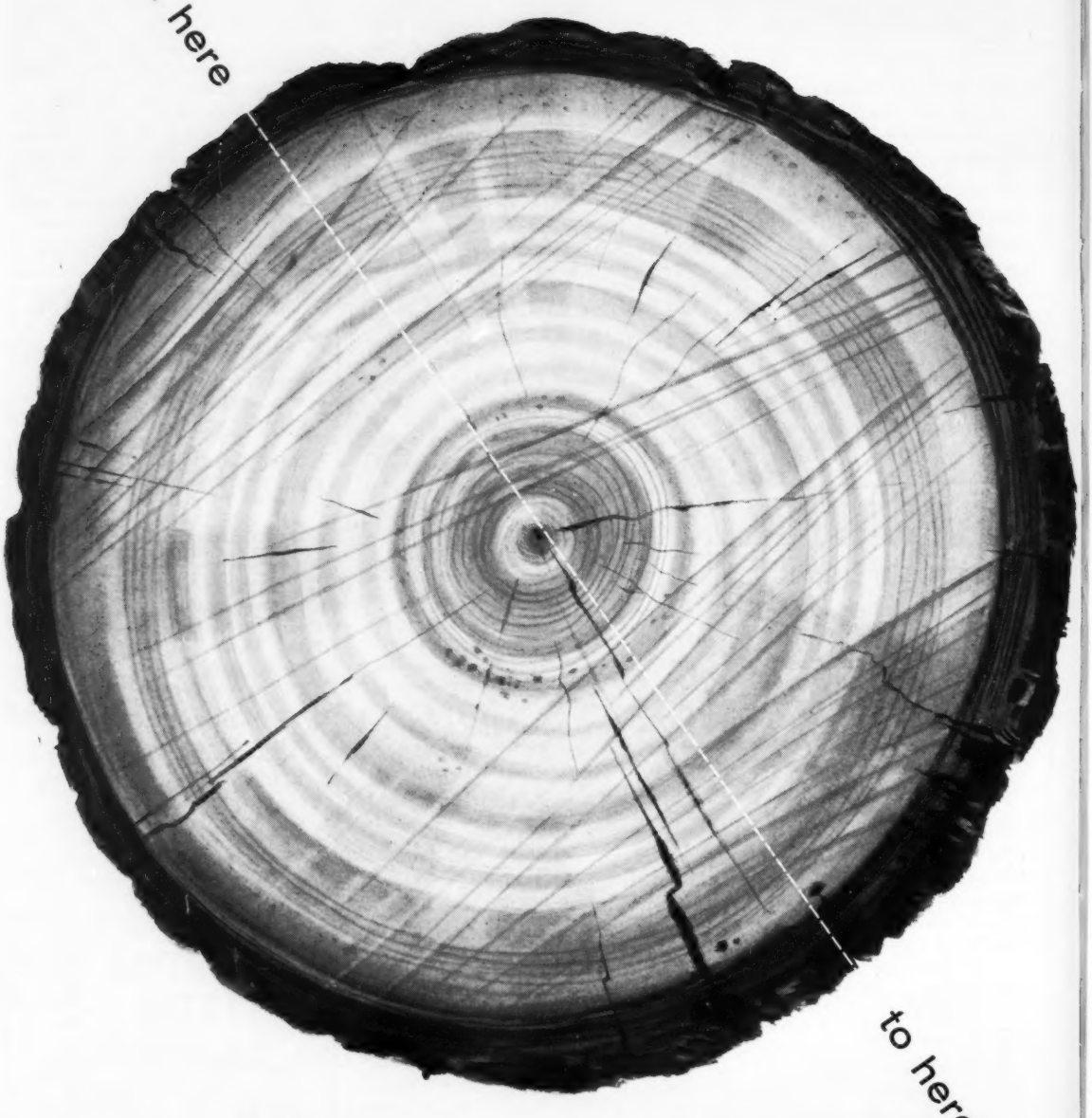

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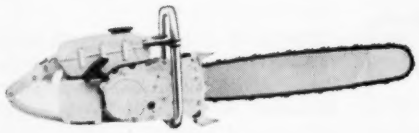

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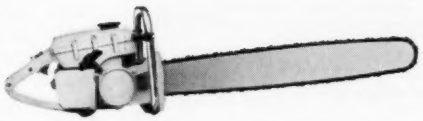

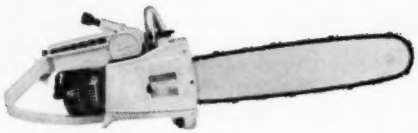

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WILLIAM HERITAGE

William Heritage Retires

William Heritage, veteran forester of the lakes states region, and member of long-standing in the Society of American Foresters, retired August 31, 1958, after some 47 years of federal service. Before coming to the Bureau of Indian Affairs, U. S. Department of the Interior, in May of 1918, Mr. Heritage served nearly seven years with the Superior National Forest. He entered the Indian Service as a cruiser at Ashland, Wisconsin. Since that time he has served in many locations on various assignments. At the time of his retirement he was the Bureau's area forester of the Minneapolis area, embracing the states of Minnesota, Wisconsin, Michigan and Iowa.

In 1956 at a ceremony in Washington, D.C., Mr. Heritage was awarded the Interior Department's highest honor — the Distinguished Service Award.

Vogel Transfers from Paraguay to Nepal

Frederick H. Vogel has recently transferred from Paraguay, where he has been for nearly four years, to Nepal as forestry adviser to the Nepalese government under the technical assistance program of ICA.

Vogel reports that he arrived in Kathmandu on June 10 and immediately got underway with field duties primarily in the field of utilization. He says the country is fascinating and a camera man's paradise.

Vogel replaces Hubert Person who

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becomes assistant to A. C. Cline, in charge of foreign forestry services, U. S. Forest Service, Washington.

New Men in Forest Service Regional Office at Portland

Regional Forester J. Herbert Stone of the U.S. Forest Service has announced the transfer of three men to the Pacific Northwest regional office at Portland, Oregon. Two are staff officers in the Division of Range and Wildlife Management and one to the Division of Recreation and Lands.

Carl W. Simpson fills the range staff position vacated by the transfer of Wayne W. West to Atlanta, Georgia. "Raymond M. West is being assigned as an assistant in wildlife management because of the increased workload in that field," Stone said. Charles E. Fox is joining the division of Recreation and Lands to assist in the increased workload in that division.

Carl W. Simpson joins the Regional Office from a staff position on the Beaverhead National Forest at Dillon, Montana. He is a native of Montana and received his B.S. in forestry degree from Montana State University in 1943.

West has been employed since 1956 with the Anaconda Copper Mining Co. A native of Oklahoma, he graduated from Oklahoma A&M College in 1933 with a major in zoology in 1934.

Fox has since 1952 worked in the Lake States Region of the Forest Service in the educational field, and it is from the division of Information and Education at Milwaukee, Wisconsin, that he is transferring to the Pacific Northwest. He is a native of New York with a BSF degree from the University of Idaho in 1928.

Industrial & Private

Industry Steps Up Aid to Southern Landowners

A record growth in the number of landowners in the South receiving free forestry services from the pulp and paper industry has occurred in the past five years, according to a statistical report released by the Southern Pulpwood Conservation Association.

Henry J. Malsberger, general manager of the SPCA, said the report points up the "highly significant progress" that has been made by the association and its member pulp and paper mills in providing landowners with

direct services leading to greater productivity of southern woodlands.

For example, the 1957 report reveals that 50,696 landowners in 11 southern states had received management assistance since an annual industry-wide survey was started in 1948, Mr. Malsberger said.

"The latest study shows that 41,611 landowners were served by industry foresters in just the past five years," the association executive continued. "Compared with a 1948 total of only 465 and a 1952 total of 9,085 landowners receiving management aid from the industry, the recent figure becomes most impressive."

Management assistance offered by association and industry foresters includes advising farmers and forest owners on cutting in a productive manner, recommending what trees should be left for future growth, or whether replanting with "superior" tree seedlings should be undertaken.

Total acreage in the South on which management assistance had been provided was 942,000 when the survey was first made in 1948, it was explained. Total acreage through 1957 was 30,604,000 acres—a five-year increase of 26,607,000 acres over the 1952 figure of 3,997,000, the report said.

The survey also showed that southern pulp and paper mills were responsible for planting 1,288,000,000 seedlings in the region by 1957—an increase of 883,000,000 seedlings over the total of 405,000,000 planted by 1952.

The Southern Pulpwood Conservation Association was formed in 1939 to aid in improving the productivity of woodlands through an educational, informational and service program directed to owners of forest lands.

Forest Industries Reveal Busy Acres Tree Growing Plan

Busy Acres, a how-to-do-it program to assist farmers and other owners of small acreages put idle lands to work growing trees, will be launched at the state level during the fall, according to John B. Veach, president of the American Forest Products Industries, the program sponsor. The program will be administered by state forest industry committees with the cooperation of other conservation groups and agencies. The objectives for the new plan are: (1) To stimulate action in turning idle acres into producing timberlands. (2) To stimulate tree planting and forest management for optimum timber production. (3) To point up the full-use values and economic potential of managed timberlands. (4) To inform landowners how to apply basic principles of tree farming under local conditions.

The Busy Acres program grew out of a nationwide study by AFPI in which nearly 200 leaders in conservation and related fields were interviewed.

John Hauberg Elected Weyerhaeuser Director

John H. Hauberg, Jr., Seattle, Washington was recently elected a director of Weyerhaeuser Timber Company. Mr. Hauberg is president of the Pacific Denkmann Company and former president of the Potlatch Yards, Inc. He is a director of Dimock Gould and Company, Rock Island Millwork Company, and the Equity Fund, Inc., of Seattle.

A graduate forester, Hauberg studied forestry at the University of Washington following his graduation from Princeton.

Michigan Man Heads Nationwide Wildlife Panel

Casey E. Westell, Jr., of Manistee, Mich., has been named chairman of a nationwide Wildlife and Forest Recreation Committee just formed by American Forest Products Industries. The committee will meet in Washington in November to discuss timber and game as twin crops, according to James C. McClellan, chief forester of AFPI. Increasing numbers of companies are employing trained wildlife and recreation managers and maintaining parks and campsites for the public's enjoyment.

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Other committee members are Kramer A. Adams, Weyerhaeuser Timber Co., Tacoma, Wash; Raymond D. Moody, fish and wildlife coordinator for International Paper Co., Mobile, Ala.; Carl F. Pierce, Allison Lumber Co., Inc., Bellamy, Ala., and George A. Gehrken, wildlife consultant, Union Bag-Camp Paper Corp., Franklin, Va.

Westell, trained as forest and wildlife ecologist at the University of Michigan is now completing work for his Ph.D. He was the first such scientist to be employed by a wood using industry — the American Box Board Co. His work in the field of whitetail deer and aspen forest management has won nationwide acclaim.

J. Neils Lumber Company Donates Area for Training Camp

In ceremonies attended by Gov. J. Hugo Aronson, members of the State Forestry Board and representatives of the University, the U.S. Forest Service, the state foresters office and the Neils Lumber Co., a tract of virgin forest land was dedicated for training Montana State University students in forest management.

The Neils Forest Camp, donated by the J. Neils Lumber Company, will be used as an experimental laboratory for the solution of forestry problems. It is near Libby, Montana, some 190-miles north-northeast of the University Campus at Missoula.

Papermakers, Forest Biologists Form New Technical Group

The early part of 1958 saw the creation of a group to cultivate interchange between forest biologists and papermakers. Organized as the Forest Biology Commtttee of TAPPI, the group has a nationally representative membership of 35 persons. About half are forest biologists active principally in forest genetics and tree improvement, but also in physiology and wood anatomy. Persons affiliated directly with the fundamentals and technology of pulping and papermaking make up another quarter of the membership, and an approximately equal-sized group represents the concerns and points of view of the woodlands departments of pulp and paper companies.

The principal aim of the committee is to put workers in the several related fields and in different institutions in touch with each other, to bring together relevant fundamental information and stimulate inquiry in significant fundamental areas, to encourage the development of suitable methods for qualitative small-sample analyses of wood, and to review the literature in selected areas which link the interests of forest biologists and papermakers.

In the initial phase of its program, attention will be devoted primarily to forest genetics and forest tree improvement, as they relate to wood as a raw material for the manufacture of pulp, paper, and paperboard.

Serving the Forest Biology Committee as officers are: Philip N. Joranson, Research Associate in Forest Genetics, The Institute of Paper Chemistry, Appleton, Wisconsin — Chairman; Bruce J. Zobel, Associate Professor of Forest Genetics, School of Forestry, North Carolina State College, Raleigh, North Carolina—Vice Chairman; Philip C. Wakeley, Research Silviculturist, Southern Forest Experiment Station, U. S. Forest Service, New Orleans, Louisiana—Secretary.

Richard Schantz-Hansen Granted Fulbright

Richard Schantz-Hansen, Fulbright scholar from Cloquet, Minnesota left August 9 for a year's study at the University of Helsinki. Schantz-Hansen, a forester on the staff of The Northwest Paper Company, will do graduate work in forest management. After receiving his B.S. in foresty from the University of Minnesota in 1953, he spent two years in the army, serving with the U. S. Ski Patrol in the Bavarian Alps. In September 1955 Mr. Hansen joined The Northwest Paper Company's division of forestry from which position he has been granted a year's leave-of-absence in order to study abroad.

Industry Committee to Help Coordinate Forest Insect and Disease Control

Forest industries have named a special committee to help plan and coordinate forest insect and disease control. The committee, appointed by the Forest Industries Council, is headed by Howard D. Bennett, Cincinnati, secretary-manager of the Appalachian Hardwood Manufacturers, Inc. E. F. Heacox, Weyerhaeuser Timber Co., Tacoma, Wash.. is vice chairman. The Forest Industries Council is the forest policy coordinating body representing the American Paper & Pulp Assn., the National Lumber Manufacturers Assn., and the American Pulp-

wood Assn.

James Madden, vice president of Scott Paper Co. and chairman of the Council, listed the following committee objectives: (1) To represent the forest industries in bringing about better understanding, coordination and cooperation among all agencies interested in forest insect and disease control. (2) To survey the forest pest situation throughout the United States and make suitable recommendations to the Forest Industries Council. (3) To stimulate interest in and action on forest pest control as an integral part of forest protection and management. (4) To encourage the formation of state and regional forest pest action committees where the need is clearly demonstrated and no such committees exist.

Education

Cope Named Acting Director, School of Forestry at Penn State

H. Norton Cope, professor of forestry, has been named acting director of the School of Forestry and acting head of the department of forest management at the Pennsylvania State University. He succeeds Dr. William C. Bramble, who has been acting director of the School since 1955 when Maurice K. Goddard was granted a leave of absence to serve as State Secretary of Forests and Waters.

Cope, a Penn State graduate, joined the faculty in 1929 as instructor in forestry and served from 1929 to 1931. From 1941 to 1943 he was resident director of the Pennsylvania State Forest School at Mont Alto, which in 1929 became affiliated with Penn State.

From 1916 to 1921 Cope served with the U.S. Forest Service and from 1921 to 1929 was a forest supervisor with the Pennsylvania State Department of Forest and Waters.

Two New Faculty Members Named at Yale

Announcement has been made of the appointment of two new members to the faculty of Yale University School of Forestry. Zebulon W. White has been named as Professor of Industrial Forestry, and Jesse H. Buell as Assistant Dean of the School.

Mr. White received his A.B. from Dartmouth in 1936 and M.F. from Yale in 1938. He served as District Supervisor of the Ohio Forest Survey in 1939-40 and as Forester for Pomeroy and McGowin, consulting foresters of Monticello, Ark., from 1940 to 1945 at which time he was made a partner in the firm. For the following 12 years Mr. White was manager of this company.

In his new position, Professor White will have charge of the Yale Forestry School's instruction in industrial forestry, and also direct the short-term seminars the School has been sponsoring in this field for men employed in the forest industries. He succeeds E. T. F. Wohlenberg, recently retired.

Mr. Buell received a B.S. from Wesleyan University in 1922, an M. F. from Yale in 1924 and Ph.D. from Duke in 1943. From 1924 to 1926 he was with the Tennessee Bureau of Forestry and for the next 30 years served with the U.S. Forest Service. He was a silviculturist from 1926 to 1945 with the Appalachian Forest Experiment Station, and was assigned to the Division of Forest Management Research in Washington from 1945 to 1951. From 1951 until his retirement from the Service in 1956 he was Chief of the Forest Management Research Division of the Rocky Mountain Forest Experiment Station.

May Joins Staff of University of Georgia

Jack T. May became professor of silviculture at the University of Georgia School of Forestry on Sept. 1. Dean Allyn M. Herrick of the University of Georgia School of Forestry, announced that Professor May is teaching graduate and undergraduate courses in silviculture and will conduct research under auspices of the Georgia Forest Research Council.

Dr. May served with the U.S. Forest Service for 15 years in seven states and was instrumental in establishing and operating the Stuart and W. W. Ashe nurseries in Louisiana and Mississippi. Since 1949, he has been teaching and carrying on research at Alabama Polytechnic Institute.

Dr. May received his undergraduate training at Mississippi State College and Louisiana State University, his M.S.F. from the University of Georgia, and Ph.D. from Michigan State University. He served as a gunnery officer in the U.S. Navy from 1942 to 1946 in the Atlantic and Pacific and is a commander in the Naval Reserve.

New Extension School in Forestry and Conservation

Announcement has been made by Charles H. Stoddard, Washington, D. C., of the organization of a new extension school to teach forestry and conservation on the sub-professional or vocational level. Courses are offered in soil and water conservation, fish and wildlife conservation and in forestry. Course material in forestry —to be published in book form—has been prepared by Mr. Stoddard. A companion volume to cover other con-

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Index to Advertisers

	Page
Adirondack Forestry, Inc.	798
Aermotor Co.	789
Atkinson, S. Gayley	799
Banzhaf, George & Co.	797
Bartlett Mfg. Co.	786
Belanger & Bourget	797
Calvert School	791
Cards of Wood	783
Caterpillar Tractor Co.	3rd Cover
Champeog Press, Inc.	772
Clifton, Thomas C.	798
Coile, T. S.	796
Crank, Porcius F. Jr.	797
Cranston, Keith	796
Deere & Co.	722
Eastman, Wm. A. Jr.	797
Fechheimer Bros. Co.	787
Forestry Suppliers, Inc.	773
Greenacres, Inc.	797, 799
Guthrie, John G.	799
Hale Fire Pump Co.	778
Hall, Albert G.	798
Hall, Jack M.	799
Hammon, Jensen & Wallen	796
Harrah Mfg. Co.	779
Haynes Mfg. Co.	788
Homelite Corporation	Back Cover
International Harvester Co.	780, 781
Keene Forestry Assn.	787
Knapp, G. Ed.	797
Kraemer, J. Hugo Assoc.	798
Kurfew, Inc.	793
Lemieux, Frank J.	799
Lind, A. L. Co.	787
Lowther, Harry A. Co.	788
McCulloch Corporation	794, 795
Mann Edge Tool Co.	785
Meadows, Ben	776
Mora Chemical Co.	774
Musser Forests, Inc.	791
National Agricultural Supply Co.	791
Nelson Co.	782
Northern Tree Co.	797
Pacific Weather Service	793
Panama Pump Co.	793
Pomeroy & McGowin	796
Pond & Moyer	798
Poulan Saw Co.	784
Prentiss & Carlisle	798
Price, William H.	799
Rich, C. H. Forest Fire Tool Co.	787
Ronald Press Co.	777
Rootspred Tree Planter	790
Sanders, Paul M.	797
Sebrell, J. B. Corp.	792
Sewall, James W. Co.	796
Silva, Inc.	787
Smith, D. B. Co.	2nd Cover
Southern Coatings & Chemical Co.	775
Southern Seed Co.	789
Stewart, Fred Assoc.	792
Stock, John W.	798
Stratex Instrument Co.	790
Timber Mgmt. Service	798
Tree Farm Mgmt. Service	799
Utility Tool & Body Co.	793
Western Fire Equipment Co.	783
Western Tree Cones	793
Whitfield, R. A. Mfg. Co.	779
Winslow, Paul T.	798

servation fields is to follow. According to the announcement "The National School of Forestry and Conservation" will make its extension courses available both to men already employed in the field, and to land owners, either for supervised in-service group study or home study. Future plans include the establishment under a professional teaching staff of resident instruction facilities at the Wolf Springs Forest, Minong, Wisconsin to which address inquires may currently be directed. An office will be maintained in Washington, D.C.

Boyce Named Director, Bartlett School of Tree Surgery

Dr. John S. Boyce, professor emeritus of forest pathology at Yale University, has been named director of the Bartlett School of Tree Surgery at Stamford, Connecticut. Dr. Boyce had been professor of forest pathology at Yale since 1929, until his retirement on June 30 of this year.

American Group Attends Swedish-American Forestry Meet

An American forestry tour group to Sweden got a good preview of management practices in second-growth stands that will be used in Oregon in the not too distant future. That's the observation of Dr. J. R. Dilworth, Oregon State College forestery professor and leader of the tour. The second-growth practices observed include a careful thinning of young stands to improve quality of final harvest and salvage of small trees which would otherwise be lost. The 22 tour members attended the Swedish-American Forestry conference, co-sponsored by Oregon State College. After the conference, they visited Swedish, Danish, Swiss and German forest areas and forest products plants.

Hosner to be Visiting Professor at Syracuse

John F. Hosner, associate professor of forestry at Southern Illinois University, was granted a nine-month's leave by the Southern Illinois University board of trustees to accept a temporary appointment as visiting professor of forestry at the State University of New York College of Forestry, Syracuse.

Dr. Hosner is a graduate of Michigan State College, received his master of forestry degree from Duke University, and his doctorate from the State University of New York College of Forestry.

Forestry Employment

Position Available

Forester to work in County Assessor's Office in California Redwood Region. Timber inventory and appraisal. Background in photogrammetry. Some expense paid travel. Good living conditions and job benefits. Permanent. Start at $400. per month.

Box T, Journal of Forestry, Mills Building, Washington 6, D. C.

Positions Wanted

Forester, B.S.F., Montana State, 1958. Age 22. Timber cruising experience and range inventory work. Desire position in Colorado. Detailed summary of experience and qualifications furnished upon request.
Box O, Journal of Forestry, Mills Building, Washington 6, D. C.

Liberal Arts (English, Economics), Forestry graduate, A.B., M.F. offers services writing, editing professional subjects for technical and popular presentation. Excellent knowledge English usage. Wide variety experience in forestry profession, wood-using industries. Interested also in challenging permanent position where diverse experience and wide interests are desired. Age 29.
Box Q, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S. Forest Management, West Virginia Univ. 1954. Age 26, single. Three years U. S. Air Force, 1/Lt. Release from active duty, December 1958. One year experience on state forest and six months as service forester. No objection to travel. Interested in foreign employment.
Box R, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F., 1956, Montana State Univ., in Forest Engineering, 3 qtrs. additional study at Minnesota in rural sociology and agricultural education. Age 28, married no children. One year state forestry work, timber management, road location and farm forestry work plus five summers employed in federal and industrial forestry. Desire position with state or extension forestry agency in Central or Western states.
Box S, Journal of Forestry, Mills Building, Washington 6, D. C.

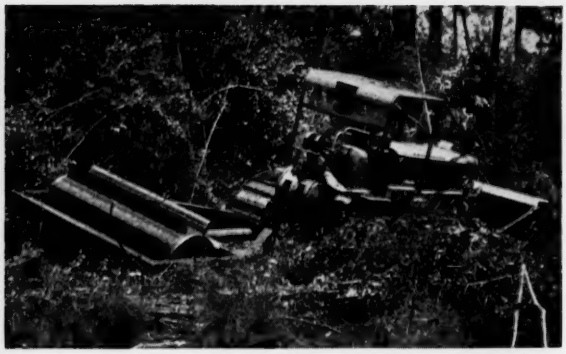
Forester, age 30, liberal arts degree and M.F. Utah State. Married, two children. Three years experience small Midwest paper mill; wood procurement, marking, scaling, some product development with specialty kraft papers. Seeking opportunity in aerial photography and IBM based CFI. Administrative or plant work indicated because minor hip injury precludes extended field activity. Excellent references.
Box U, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F., 1947. Age 41, married, two children, veteran. Employed in private industry. Desire change for better opportunity for advancement. Management and administrative position in Southeast preferred.
Box V, Journal of Forestry, Mills Building, Washington 6, D. C.

Experienced professional forester, B.S.F., 1949. Age 36, married, two children. Thoroughly qualified in timber and land management, cruising, acquisition appraising, fire control, timber sales, and land surveying. Experienced in operational planning, and personnel training methods and administration. One year federal forestry, eight years industrial forestry (present employment). Desire permanent position.
Box W, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F., 1938. Married, one child. Varied experience in private forestry in the South and Central States. Will consider any type of forestry work.
Box Z, Journal of Forestry, Mills Building, Washington 6, D. C.

HOW RIEGEL USES CAT DIESEL TRACTORS FOR PROFITABLE SITE PREPARATION



One of two D7s: Pulling a rolling chopper, this D7 equipped with No. 7A Bulldozer covers 17 to 20 acres a day. Riegel gets the same production from its other D7. Riegel also uses its D7s, rated at 128 flywheel horsepower, for road construction.

One of six D6s: Preparing site with a disc harrow, this D6 averages 6 to 8 acres a day. Riegel counts on similar production from its other D6s. Rated at 93 flywheel HP and equipped with No. 6A Bulldozers and winches, these machines also build roads and fire lines.

One of three D4s: Equipped with No. 4A Bulldozers, Riegel's D4s are often employed for light site preparation. Their main duty: fire line work. Rated at 63 flywheel horsepower, they're also used for clearing right of way, like the D4 shown here.

Of the 235,000 acres in its Woodlands Division, Bolton, N. C., the Riegel Paper Company clears and plants 10,000 acres a year with about 9,000,000 pines. The Division, standardizing 100% on Cat-built machines, has 12 in its line-up—two D7s, six D6s, three D4s and a No. 12 Motor Grader. Chief Forester E. S. Thornton says: "We are well satisfied with the tractors and the service we get from our Caterpillar Dealer."

Standardizing on rugged yellow machines has many advantages. Their availability is exceptionally high. They work day after day with a minimum of down time and maintenance. For example, the exclusive Caterpillar oil clutch delivers 2,000 hours without adjustment. Other advantages: operator familiarity with one make of machine means greater production. And there's a big plus in one-stop service, wherever and whenever you need it, from your Caterpillar Dealer. From the D4 (63 flywheel HP) to the take-charge D9 (320 flywheel HP), there's a Cat Diesel Tractor suited for every phase of site preparation.

To help you in your selection, Caterpillar has compiled cost analyses of its tractors in a wide range of jobs—Stump Treatment; Stump Clearing and Tree Cutting; Chaining; Raking and Windrowing; Harrowing; Planting. For further information, write Logging Section, Caterpillar Tractor Co., or call your nearby Caterpillar Dealer.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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FIND YOUR CATERPILLAR DEALER IN THE YELLOW PAGES

MODERN HEAVY-DUTY MACHINES FOR PROFITABLE SITE PREPARATION

Portrait of a man making money with the new HOMELITE 7 21 Chain Saw

This man has put himself in the money making picture with the light-weight, fast-cutting Homelite 7-21 chain saw. Weighing only 21 pounds*, the 7-21 is balanced for easier, safer handling in any cutting location, any cutting position . . . lets you cut longer with less strain and effort. Its rugged gear drive delivers enough lugging power to fell trees up to 7 feet in diameter; enough speed to cut through 20" trees in 18 seconds.

Designed for the professional woodsman, the Homelite 7-21 has the 7 magic features that mean greater dependability, less down-time, more profit for you. These include features like: the famous Homelite high-compression, short stroke engine that delivers full cutting power in any position . . . tough, drop forged counterbalanced crankshaft to assure smooth running . . . simple piston pump oiling . . . automatic governor to maintain proper speed . . . large air filter to keep out sawdust, dirt, snow.

All these and the many other features of the 7-21 have been designed to put you in the money making picture. Find out for yourself, see a free demonstration of the Homelite 7-21 chain saw at your nearby Homelite dealer's.

*less bar and chain

Guaranteed for a full 7 months

Full line of attachments: Plunge-cut bow, 14" and 18"; brush cutter, clearing bar. Straight blade sizes 14" to 60"

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In Canada: Terry Machinery Co., Ltd.